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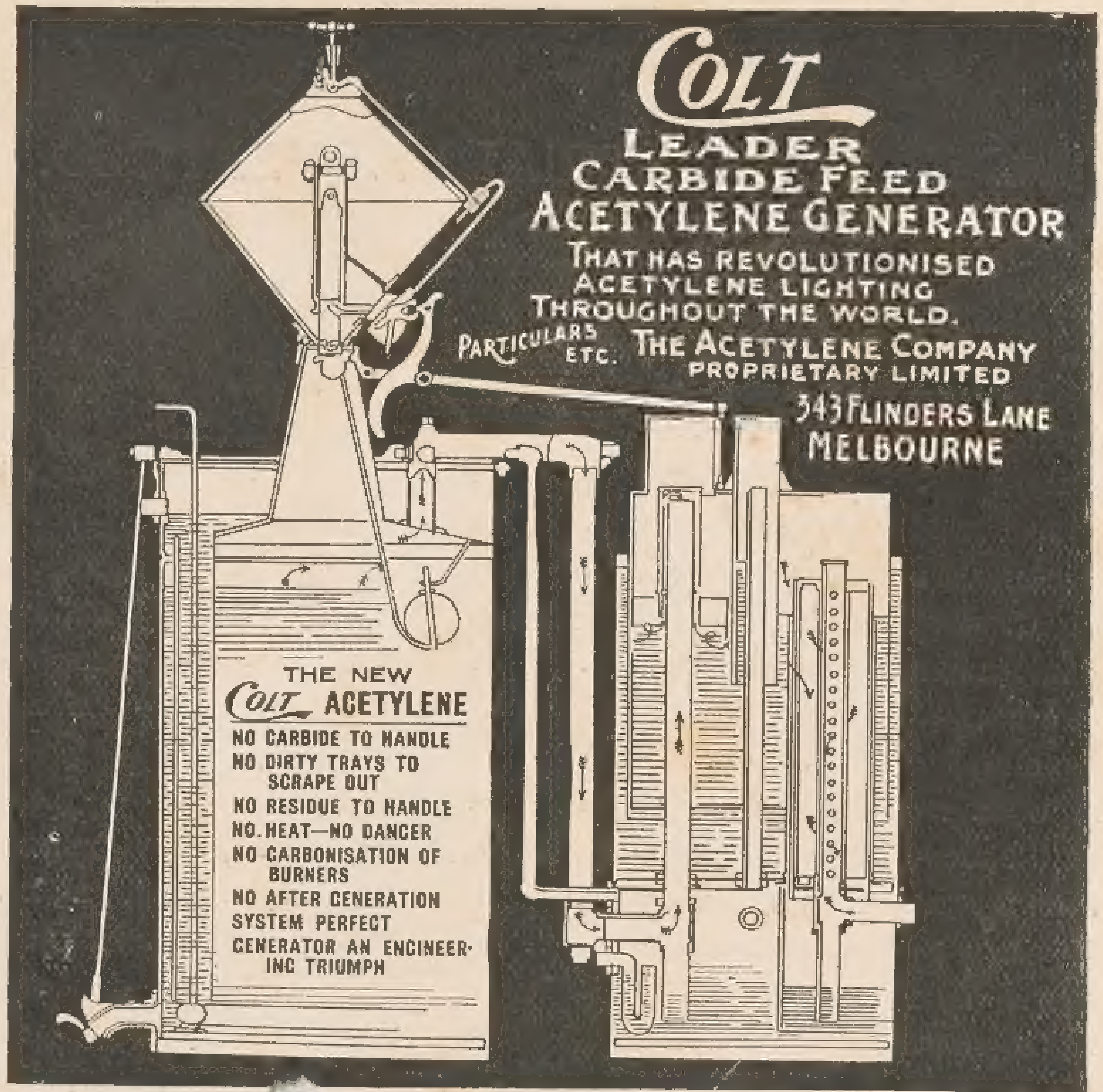

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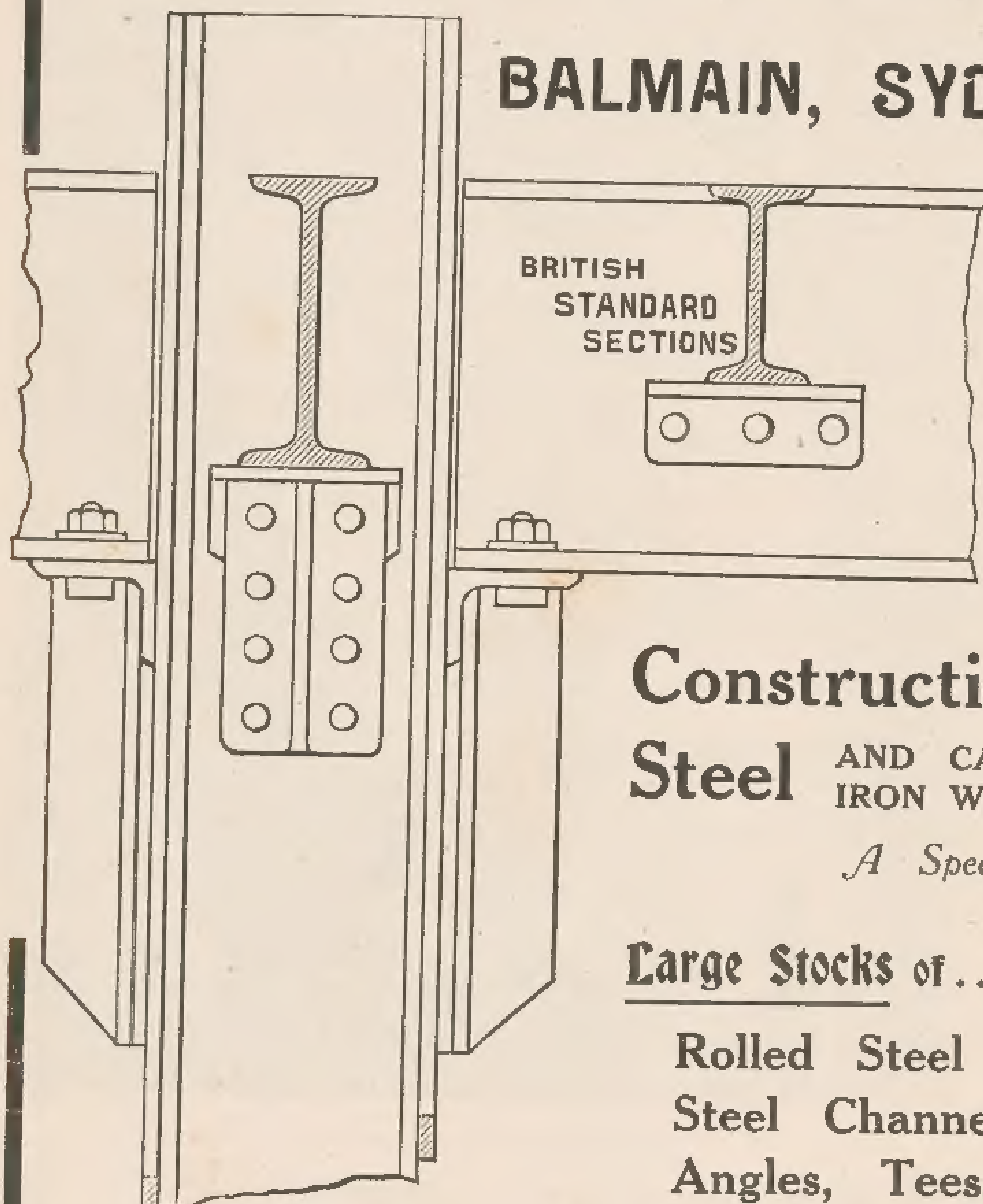

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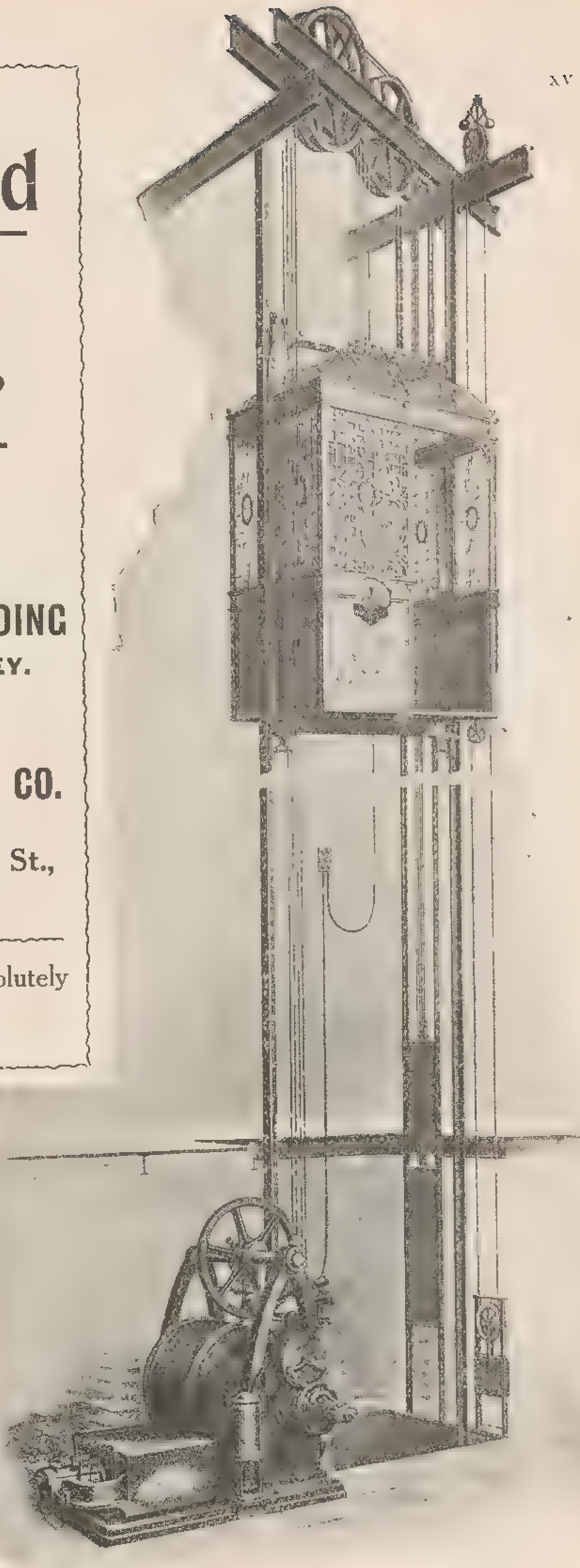

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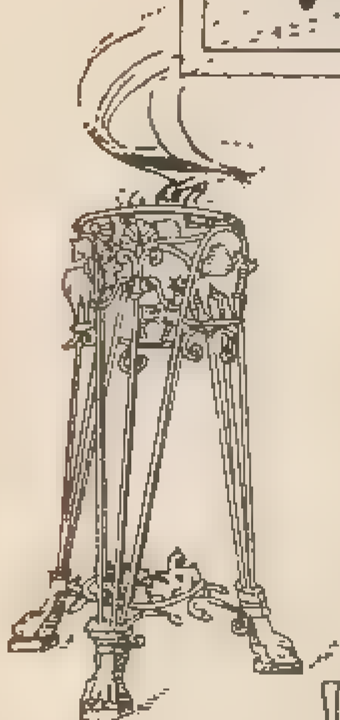

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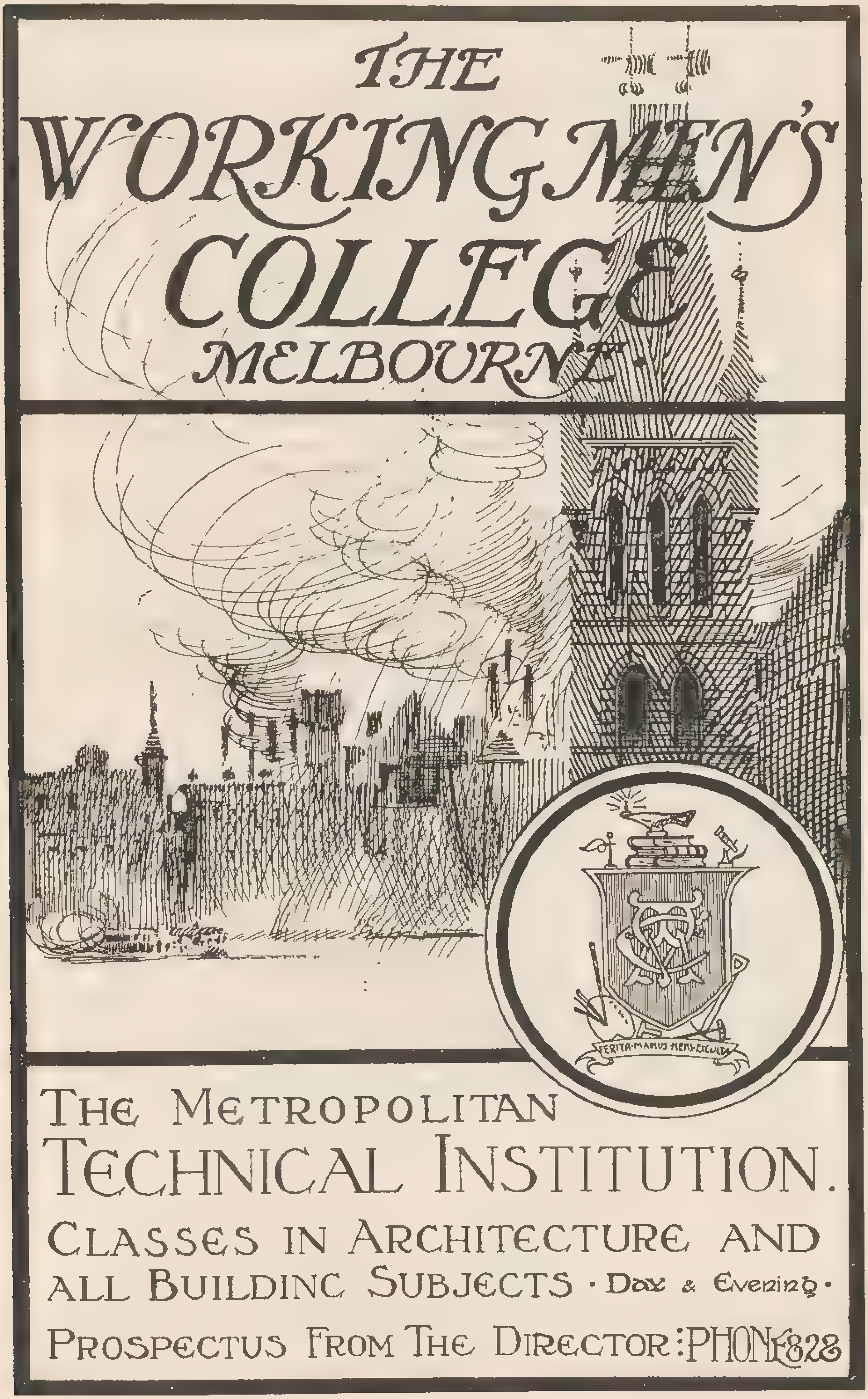
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AUSTRALIAN ARCHITECTURE

AUSTRALIAN ARCHITECTURE

A Technical Manual
for all those engaged
in Architectural and
Building Work.

BY

ROBERT J. HADDON,

ARCHITECT.

FELLOW OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS.
FELLOW OF THE ROYAL VICTORIAN INSTITUTE OF ARCHITECTS.
FELLOW OF THE SOUTH AUSTRALIAN INSTITUTE OF ARCHITECTS.

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AUTHOR'S NOTE . . .

THAT the time is ripe for a book upon Australian Architecture, there can be no doubt, for, when we remember the large and ever increasing expansion of building operations throughout the Commonwealth, we are reminded that our own peculiar conditions, climate, and materials must needs require special and peculiar consideration.

It may at once be conceded that the Technical Books from England and America that come from time to time into this market do not cater for the special needs of Australia. This fact has been very specially borne in upon me during the course of a busy Consulting Practice; and it is well known among Architects, Technical Instructors, and Builders that such imported Text-Books—while often admirable in the highest degree for their purpose—fail when applied to the problems that the Australian has to face.

The introduction of this book, therefore, needs no apology when it seeks to place in the hands of those needing information the leading practical facts to be remembered in the carrying out of Building Works.

ROBERT J. HADDON.

BROUGHAM CHAMBERS,
CHANCERY LANE,
MELBOURNE.

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AUSTRALIAN ARCHITECTURE

CHAPTER I.

INTRODUCTION.

In considering a treatise upon architecture, we are reminded of the very many points of peculiar difference that must always separate our Australian requirements and practice from that of the old world.

With climate distinct from others, with building materials of distinctive character, and with requirements of life, business, and habit differing in many degrees from the old civilization of lands of ancient settlement, we are faced with problems, in our building, which require the application of special study; and it is the object and purpose of this manual to direct attention to some Australian requirements, and to provide ideas and suggestions for meeting difficulties of a local character in Australian building work.

No small part of the work of progress in Australia is the craft of building; a craft that at once touches the interests of every man in the community and includes not an inconsiderable number, in the labours involved in the many trades and callings, depending upon the building trades for their maintenance. With those who provide, and those who build, are the men who direct—the men of technical skill and trained intelligence in construction and design, whose knowledge needs to be so directed that all this building may be done to good purpose, that all this energy of effort may be concentrated to the wisest ends and the highest purposes.

To help in the training of such men is, therefore, the object of this treatise, and to place within easy reach of students facts and examples of building practice that may assist in the practical application of local building.

VALUE OF HISTORY.—At the outset of architectural study it is well to remember the inestimable value of history.

We are reminded that architecture is one of the most ancient of all the occupations of man, and that his work in this direction marks his progress and decline all down the ages. So that in history we have laid out for our instruction and inspiration, works in construction, design, and sentiment, which should help us the more perfectly to lay in our own building foundations both true and strong, and building worthy of Australian progress.

The study of architecture is, therefore, the study of the history of the race, for, side by side with man's development, there has been manifest his skill in building and his knowledge of the designer's art. The language of architectural expression is also, it may be remembered, a universal language, free from the narrowing influences of varying tongues; hence we, in these modern times, are made rich heirs of all the ages, for, by personal travel and also by the printed and illustrated literature, so abundantly given to the subject, we may acquaint ourselves with the best that has been done by the great designers and builders of the past, and thus prepare ourselves for the tasks of our own time and day.

The student should, at the outset of his career, endeavour to acquire that indispensable quality of mind, the faculty of observation, and, with this quality, also habitually "draw" what he sees, just as the literary student reads up his history, his best authors, and makes both mental and written notes upon events and styles, so the student in architecture should see, as far as possible, the best of the old buildings; and, by sketching and noting, gradually build up in the mind an ordered knowledge of style and practice.

Taking, therefore, as a starting point of study, some good standard book upon the history of architecture, the student will be able, step by step, to follow the progress of the ancient builders; and, as he proceeds, will find it convenient to look up other books, records, and illustrations bearing and enlarging upon each special building period which he may be studying at the time. This

method he will find of inestimable value to him, in his subsequent work of knowing the architecturally good from the architecturally bad; and in developing in himself that technical knowledge, without which he must inevitably fail when faced with the actual problems of his calling.

Side by side with the reading of books, should be the "drawing of examples," which must be done systematically, the leading characteristics of each style being illustrated, especially with regard to their general methods of construction and design, and their peculiar moldings, features, and ornaments. In the old world, such studies should be conducted side by side with the taking of measurements, and actually plotting and drawing to scale portions of good old examples, but in Australia, this being impossible, recourse should be had to the very best buildings here existent, and the student should take some selected portion of such buildings, and carefully measure, plot in a notebook, and afterwards draw to scale for future reference, making notes, meanwhile, of the materials used, and the varying methods of construction. The mind will, in this way, become acquainted with the form and size of objects, and their appearance, when delineated upon paper, in the form of scale expression.

The classics should be carefully studied, for they lie at the basis of all we know of those styles that are identified with the "orders of architecture." They lead through the dim past of Egyptian mysticism to the culminating beauty of Greek art, and to the masterful development of the great imperial style of Rome, that later on inspired the renaissance.

Through the East, we see the richness and grace of Byzantine art, with hanging dome and iridescent mosaic, and winding and threading through the life of the mediæval ages of the western nations, we come to the ennobling grace of Gothic architecture.

The modern work, the world over, tends to remind us how progressive has been the knowledge of science and the practice of hygienic laws, which find their reflex in present day building, to

which earnest study we should direct our attention, so that, from the old and from the new, we may gather the best for our Australian building.

Materials.—It is important, too, that building material should be carefully considered.

In speaking of building materials we have to remember the far-reaching and ever-increasing complexity of this great section of building knowledge.

That the designer must "know" his material, is of the greatest importance, and no pains should be spared in making acquaintance with that section of knowledge that bears upon this aspect of builder's work.

The space at our disposal in this book is, however, quite inadequate to lay before the reader anything like a thorough manual of building material, for the subject is so vast, and the range of inquiry so extended, that many volumes would be required to do justice to it.

Apart, altogether, from the ordinary structural materials that are more or less well-known to all those who build, materials are constantly being supplanted with manufactured materials of various kinds which require attention, and from which the designer may select materials for the work for the time being under consideration.

Many of these materials are manufactured by more or less secret processes. Placed upon the market with ample advertisement and business recommendation, it is only by actual test and personal experience and use, that such materials may be specified, which use, even with good materials, has to be varied, according to place, position, and circumstance.

Every department of building is entered by the manufacturer who seeks the use of artificial rather than natural material, from artificial stone to the latest embossed surface finish or sanitary paint.

Great technical knowledge and discretion is therefore required, in selecting, to accept, and use the best, and to avoid doubtful and unsatisfactory goods.

In certain chapters of this "Manual," materials will be touched upon under the various trades, and this mention may be supplemented by the student in the broader fields of test and practical experience.

In dealing with a building material of whatever kind, its "quality" should be understood, and its treatment (*i.e.*, its working and use) be accordingly arranged.

This "quality" is of the highest importance. Take a brick, for instance; an ordinary brick is a manufactured article burnt in the fire, which, if a good brick, is turned out reasonably square, uniform in color, with a hard resisting surface. How should such an article be treated? It is obviously unreasonable to seek to make a cabinet work finish of it.

To smear it over with added color, to tuckpoint it with more or less mock joints is, therefore, to destroy its natural quality. It is brick, and if built into honest walling, with good bonding and careful weather-tight jointing, must look what it should look, strong and sufficient in itself.

Take again terra-cotta or glazed faïence; these materials, being baked, can never be made absolutely true like worked stone. Their "quality" is revealed in a certain amount of happy variation; especially is this the case in faïence, where the guttering of the coloring matter leads to the variation of density so charming in this material, while its glazed surface gives further opportunity for a reflecting effect, peculiarly its own.

It is unreasonable, therefore, to look for uniformity in this material. Its quality is in its variation.

Again, in stonework, leaving out the question of surface marbles, the reasonable treatment of structural stone is to build the blocks side by side and one upon another, yet, it is not unusual to see such a case as red granite panels of unequal shape set into grey

granite walling, following the methods of wood inlay rather than any quality of hard stone masonry.

Masonry, of all structural works, lends itself the most happily to clear, obvious, constructive truth.

And so on with other materials—all have their own "quality." Among the metals, each has its own nature. One is brittle, like cast iron; the other is bendable, like wrought iron. There is the pliability of lead, though it possesses excessive expansive and contractive tendencies, the malleability of copper, and so on.

In timbers, especially, this quality should be considered. In the cutting, the nature, the way a piece of timber may be sawn, even the direction in which it is best planed, varies greatly in different woods.

There is the long, tenacious fibre of Oregon, the soft, mild, broad surface of clear pine, the brittleness of edge of redwood, the hardness of jarrah, the beauty of grain of blackwood; all capable of being applied, worked and finished, where the best qualities of each may be brought out by true craft labor to the best advantage. "Quality," therefore, is of the greatest importance in right building.

Sight Teaching.—In dealing with technical details, and especially in endeavouring to make clear to the uninitiated the various methods of present day construction, special attention has been given to the production of the numerous drawings illustrating this "Manual," and the student should so study these in the various chapters as to learn as much as possible from them.

The author is aware of the extreme value in such a study as architecture of sight teaching, and with limited descriptive space at his disposal has endeavoured to teach, as far as possible, by means of diagrammatic illustration.

This aspect of the book is therefore specially urged upon the reader.

CHAPTER II.

ARCHITECTURAL DRAWING.

THE student should give diligent attention to the acquiring of a sound knowledge of architectural drawing, for it is chiefly by this means that he will be able to make clear the technical details, both of design and construction, required for the guidance of the workmen engaged in the actual operations of building.

Later on it will be seen how the drawing has to be supplemented by the specification, which is a document describing, by means of words, the work shown upon the drawings. The two—the drawings and the specification -both being necessary as instructions and direction, to those who actually carry out the building works.

Before commencing architectural scale drawing, it is essential that the student should acquire some knowledge of plane geometry, and be able to draw readily from set objects, as well as to produce freehand and shaded drawings from architectural ornaments. This class of instruction can generally be acquired at a technical school; the art of architectural drawing is, however, best learnt in an architect's office, supplemented by evening technical instruction.

It will also soon be seen that a student cannot proceed far in the making of an architectural drawing without a practical knowledge of building construction, and his progress in drawing must proceed side by side with his studies of construction and of the actual forms and designs of buildings, and the materials of which they are composed.

EQUIPMENT.—For architectural drawings a small and well-chosen equipment should be obtained, consisting of the following :—

Drawing Board or Boards.—These are best made of clear pine to

finish $\frac{3}{4}$-in. thick, glue jointed, and deeply grooved at back every $2\frac{1}{2}$ in. of size to allow $\frac{1}{2}$-in. margin around paper generally used, and having two slot-screwed cedar ledges at back and blackwood slips at edges for T square to work upon.

Mathematical Instruments of good lasting quality, consisting of large size dividers, compasses (for pencil and for ink, with lengthening bar), medium size bow pen and pencil, and set of three small spring bows, one with points, the others holding pencil and pen respectively. These, with one or two drawing pens, will be found sufficient for all ordinary purposes.

T Squares must be of lengths to suit drawing boards, the best being of cedar with ebony edge, but good quality squares are also obtainable in pear wood.

Set Squares of either black vulcanite or transparent celluloid—one 60° 8-in. and one 45° 6-in.

Scale Rules of boxwood, one showing clearly $\frac{1}{8}$-in., $\frac{1}{4}$-in., $\frac{1}{2}$-in., 1-in., each scale on one edge only, and another showing $\frac{1}{16}$-in., $\frac{3}{8}$-in., $\frac{3}{4}$-in., $1\frac{1}{2}$-in., 3-in. scales, or, better still, one scale upon each rule, which is much more convenient for working, or the student may make neat paper scales for his own use.

Drawing Paper of "Whatman's" make, with "medium" surface, is best for all general working drawings, either double elephant (40 in. by 27 in.) or imperial (30 in. by 22 in.) For details and full-sized drawings, a cheap, tough cartridge paper, about double elephant size, purchased in quantity and stored flat, as all drawing paper should be (not rolled), is best, while for details requiring special length, white wall-lining paper may be used.

Pencils.—The pencils used should be the best drawing pencils obtainable. For the Whatman's paper, H and HH are the best grades, while cheap HB and BB pencils will be found good enough for the work of detailing upon cartridge. A box of stick charcoal should be kept on hand, for use in "trying in" large moldings, curves, and ornamental features.

Inks.—The old-fashioned method of rubbing up stick ink may

now be abandoned, and a supply of waterproof bottled ink, and a small bottle each of blue and red, obtained.

Colors. -Hard cake colors by reputable makers are the best, and the following list will be found sufficient for all general purposes:—

Alizarin Crimson	Yellow Ochre	Prussian Blue
Venetian Red	Burnt Sienna	Indigo
Gamboge	Burnt Umber	Payne's Gray
Hooker's Green, No. 1	Neutral Tint	Neutral Orange.

Brushes.—For coloring, sable brushes are best, and two or three should be obtained, as small, medium, and large, or, if found too expensive, camel hair may be substituted.

Palettes.—A nest of half a dozen white china palettes will be found the best for use in mixing the colors, to which one or two white glazed tiles may well be added.

Etcs.—A supply of soft red india-rubber and some linen rag, for cleaning pens, should also be obtained, as also one or two ink erasers, a sharp penknife, a supply of $\frac{1}{2}$-in. diameter flat drawing pins, a protractor, which is an instrument on which is marked the degrees of the circle used for setting out angles of any required degree, also a 7-in. clinograph, which is a wooden square, so adjustable as to be set for the ruling of roof slopes and similar angles; two or three French wooden curves, and a supply of ticking slips, which are long lengths of paper about 1 in. wide, cleanly cut from cartridge paper, and used for marking off sizes, for conveyance from one part of a drawing to another; a 2-ft. ordinary rule, a 6-ft. folding measuring rod, and a 66-ft. tape, together with a supply of note books, one or two being of the blue-lined, scale-ruled type, for plotting measured up work.

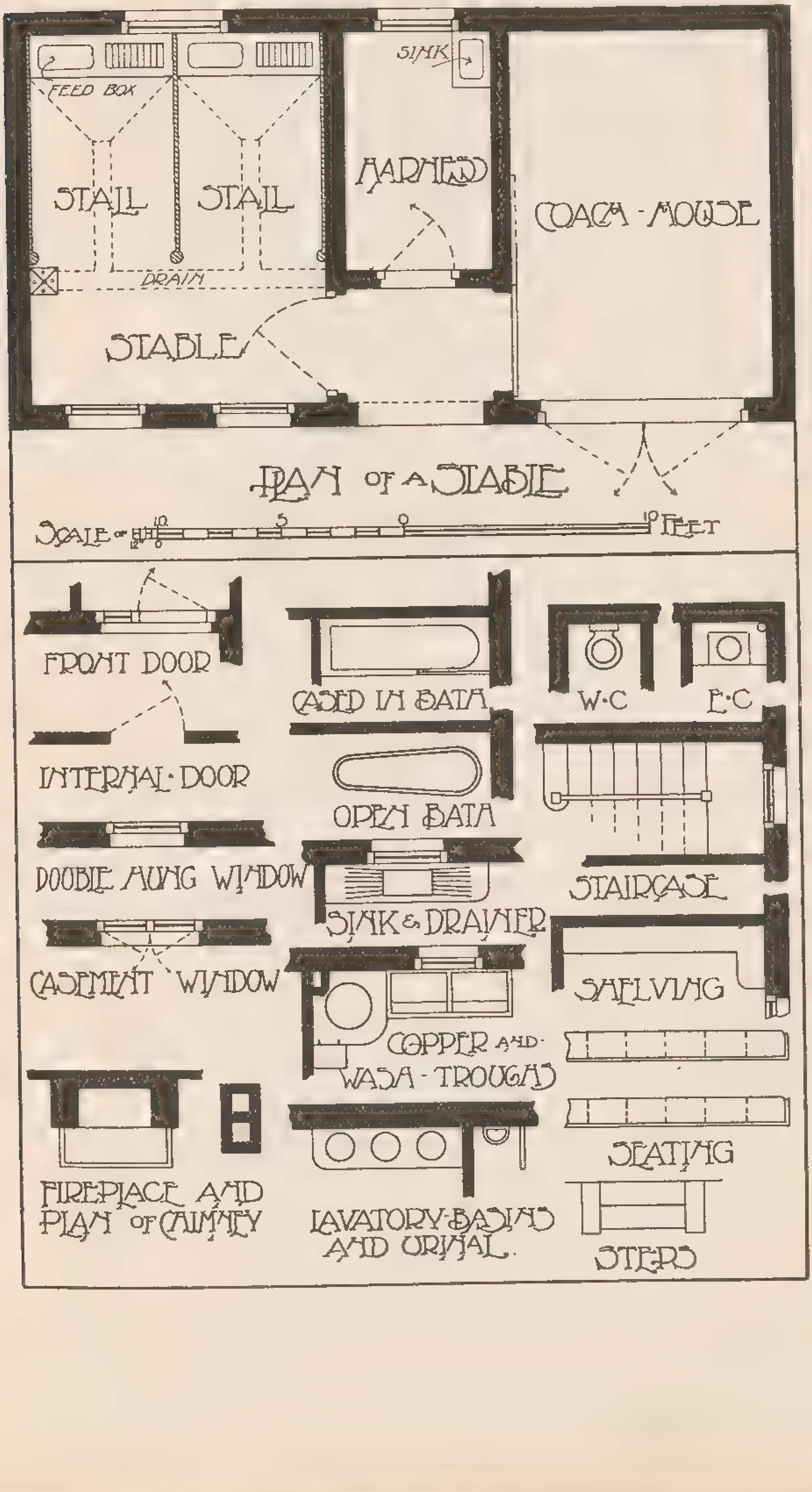
Scale.—The proper use of the scale is at the basis of all architectural drawing, and the student should early seek to master its difficulties. The scale in almost universal use for ordinary "working drawings," or, as they are often called, "contract drawings," is the one-eighth scale—*i.e.*, a scale in which every one-

eighth of an inch represents a foot—set out in feet and in tens of feet (see scale on Plate III.), so that the use of the scale consists in drawing each part of a proposed building, such, for instance, as the rooms, walls, fire-places, doors, and windows, so that when read off by the scale they will show feet and inches on the scale equal to what is required in actual feet and inches in the building. When greater detail of special parts of the structure is required, the size of the scale has to be increased; hence we find the $\frac{1}{2}$-in. (the $\frac{1}{2}$-in. representing a foot) and the 1-in. scales (1 in. representing a foot) being more generally used for details, while for actual moldings, enrichments, and ornaments, drawings should be made the actual size, which is then called "full size."

It should also be remembered that an architectural drawing is a conventional way of showing certain objects, such objects being, for the most part, too large to show actually. The device is, therefore, resorted to of showing them in a certain conventional way. To make this clear, refer to Plate I., in which a short list is given of common objects used in planning, and the way they are generally shown upon a scale drawing. This list the student may greatly add to as he proceeds, as innumerable instances will be presented in the course of his drawing practice. Take, for example, the case of door panel moldings, where, in a width of $1\frac{1}{4}$ in., there are actually perhaps four lines, or an architrave mold 6 in. wide, containing, perhaps, 9 lines. These could not possibly all be shown to a small scale; the outer and the inner, and perhaps one intermediate line, are therefore taken, and the width over all shown. The same rule is applied to turned work, such as stair newels, verandah posts, also to carving, &c.

Drawing.—At this stage a short general lesson upon architectural drawing will not be out of place.

It is assumed that a sketch design (not necessarily to scale) for a lodge cottage has been given to the student, the sketch giving size of apartments, height of ceilings, thickness of walls, position of


FEED BOX
SINK
STALL
STALL
HARNESS
COACH-HOUSE
DRAIN
STABLE
PLAN OF A STABLE
SCALE OF 10 5 0 10 FEET
FRONT DOOR
CASED IN BATH
W·C
E·C
INTERNAL·DOOR
OPEN BATH
DOUBLE HUNG WINDOW
SINK & DRAINER
STAIRCASE
CASEMENT WINDOW
SHELVING
COPPER AND WASH-TROUGHS
SEATING
FIREPLACE AND PLAN OF CHIMNEY
LAVATORY-BASINS AND URINAL.
STEPS

doors, windows, fire-places, &c. The levels of the ground, the north point, and such particulars as thickness of walls, roof pitch, roof covering, &c., such as Plate II.

The first proceeding should be to make a rough scheme for preparing a set of working drawings, say to a $\frac{1}{8}$-in. scale, and this should be done by first estimating the space that will be taken up by the various parts of the drawings, such as plan, four elevations, two sections, and roof plan upon the paper, thus assuring neatness of grouping.

Having, then, the size of paper and general scheme settled, proceed to pin down the sheet of Whatman's drawing paper, which may be in this case a half sheet of double elephant. Hold the sheet up to the light and observe the water mark, and, when right side up, *i.e.*, so that lettering is not reversed, lay the sheet upon the drawing board within half an inch of the left side edge (let it be square with board), and then pin it at the four corners, within $\frac{3}{8}$-in. of the edge, with drawing pins closely pressed home. Next, lay the stock of the T square to the left-hand edge of the board, and, having sharpened your pencil with a long, sharp point, proceed, using the T square for all horizontal lines, and the set square for all vertical lines, to set out firstly the plan, using the one-eighth scale to express all the sizes given, and afterwards the elevations, sections, &c., as shown in Plate III.

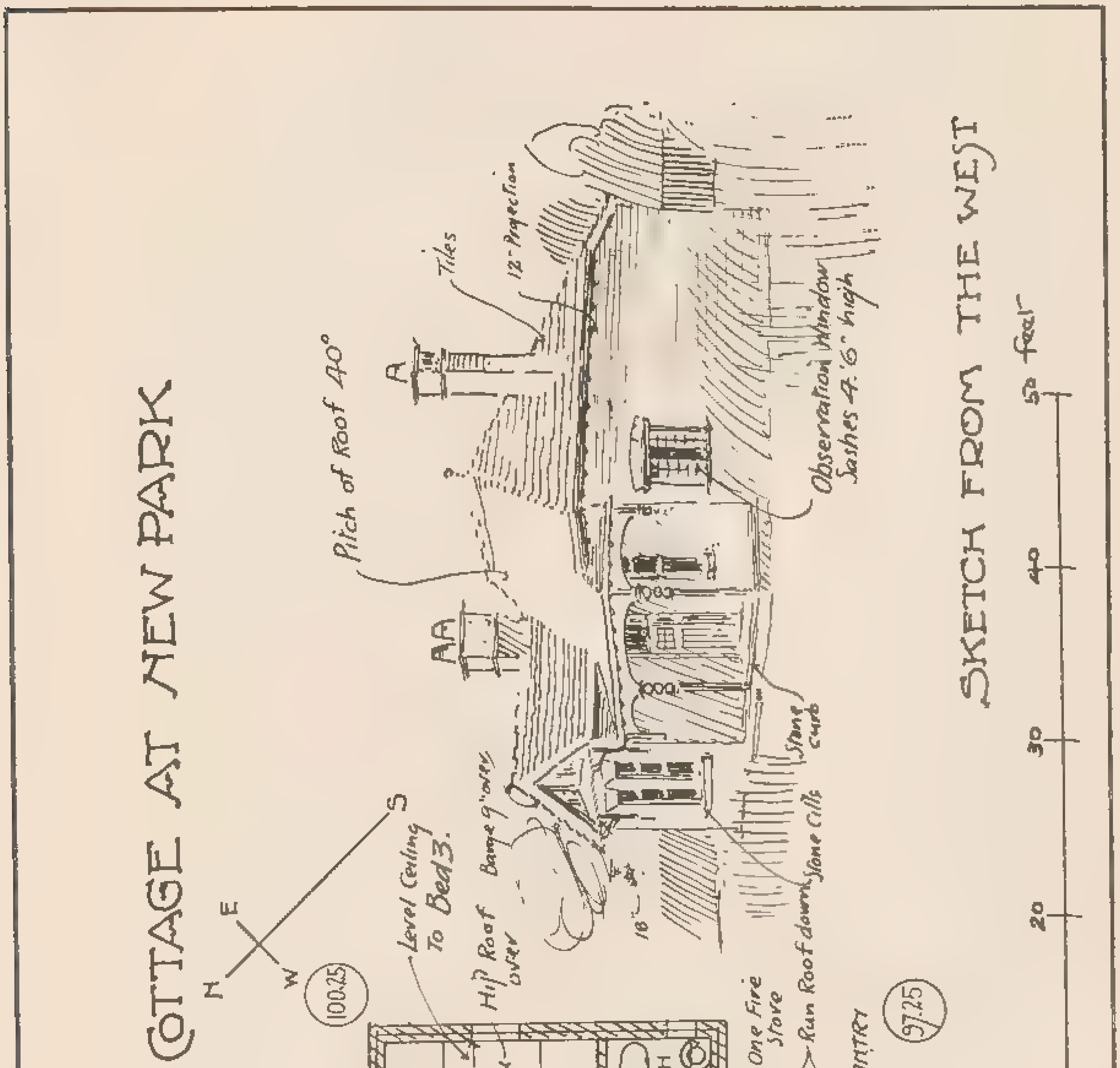
Beginning at the plan, commence at the top left-hand corner by laying down a long horizontal line, upon which may be scaled off the sizes of—Bed 1, 13 ft.; Bed 2, 11 ft.; Bed 3, 11 ft.; with $4\frac{1}{2}$-in. walls between, and 11-in. hollow outside walls. This scaling off is merely laying the scale upon the paper, and with the sharp point of the pencil marking off the sizes required. This is better than the usual way of taking off sizes from the scale with dividers. Next lay down the 12 ft. width of Bed 1, draw horizontal lines of walls, and so on, proceeding, in the general way, to lay down all walls, avoiding at the first touch details as doors, windows, fire-places, &c.

Having neatly drawn the general scheme of apartments, next proceed to put in the windows, and here the very important principle of "centre lines" should be remembered. Let each part of a plan such as rooms and fire-places be divided into two equal parts, and a working centre line laid down, which is to be repeated on both elevations and sections. These centre lines will be in pencil only, but by their aid the draughtsman will be able to set out and check the accuracy of his work far better than in any other way. After the windows, the door openings should be shown, with the hanging way of the doors added. The fire-places can then be put in, and such details as kitchen sink, pantry shelves, bath, verandah tiles, outside steps, &c., be indicated. The brick sleeper piers under the floors, as also bearers and floor joists, are also better shown upon the plan by dotted lines.

After the drawing of the ground plan proceed with the roof plan by first of all laying down a simple outline, showing the outside line of all walls, and from these build up the lines of the roof, showing projections of eaves, gables, &c., position of hips, valleys, chimneys, with their gutters, flashings, &c.

Next proceed to set up one of the sections, say A–A, and in so doing remember that a section is an imaginary cut through a building, so arranged as to show what is most necessary for the builder to know about the construction. The first line of the section should be the ground floor line, which is better ruled right across the paper, and is often fixed as a "datum" line, from which all heights and depths are measured, whether upon the drawings or upon the actual buildings. The position of the walls, doors, &c., are first obtained by paper ticking off the plan -*i.e.*, marking on a slip of paper laid upon the plans the position of the various parts, which are then transferred to the sections drawn up, and the heights added. In the same way the other sections should be proceeded with, as also the elevations (external parts) of the four sides of the building, all as shown in Plate III.

It will be seen, by the arrangement of the drawings upon the


SKETCH DESIGN for LODGE COTTAGE AT NEW PARK
SKETCH FROM THE WEST
PLAN
Pitch of Roof 40°
Tiles
12" Projection
Observation Window Sashes 4' 6" high
Stone Curb
Stone Cills
Run Roof down
Level Ceiling To Bed 3.
Hip Roof over
One Fire Stove
PANTRY
BATH
BED 3
BED 2
BED 1
PASSAGE
KIT.
LIVING
Tiles
11" hollow walls Outside
(10.0) Ceilings
Floor level 100.75
Scale of
Feet

paper, how time is saved by having, in one long top line, the three elevations and a section, as the T square is able to carry from one to the other heights and levels common to each. The same rule applies to the elevation and section upon the lower line, while, from the position of the elevation over the plan, the lines may be carried up directly off the set square.

After the various parts of the drawing have been drawn in and carefully overlooked and checked, proceed with the lettering and figuring.

In this connection it is advisable to study and practice lettering and figuring of various kinds before attempting work upon a finished drawing.

The student may, if he will, study books of lettering, and work out various styles, but there is a danger of confusion by reason of the great variety of fancy lettering. For the purpose of a working drawing it is best to keep to two plain styles—viz., plain block lettering for headings and general purposes, capable of being rapidly produced by a broad ball-pointed pen, and clear script writing for small notes, &c., supplemented by plain figuring of the various dimensions.

For sketch drawings or studies of any special style of architecture, lettering specially in character with the work may be employed, such as Roman for Roman, Gothic for Gothic, while the many elegant forms of modern lettering will give rich opportunity. The lettering should have pencil horizontal guiding lines, as should all lettering, and this may be taken as a rule throughout architectural drawings, as dissimilar from other drawings. Use mechanical aids to accuracy upon every occasion. These aids may be rubbed out when the inking in has been completed. Pencil lines top and bottom should therefore be used, and the lettering carefully centred and drawn in in pencil, regularity and evenness of size being maintained according to the position upon the sheet.

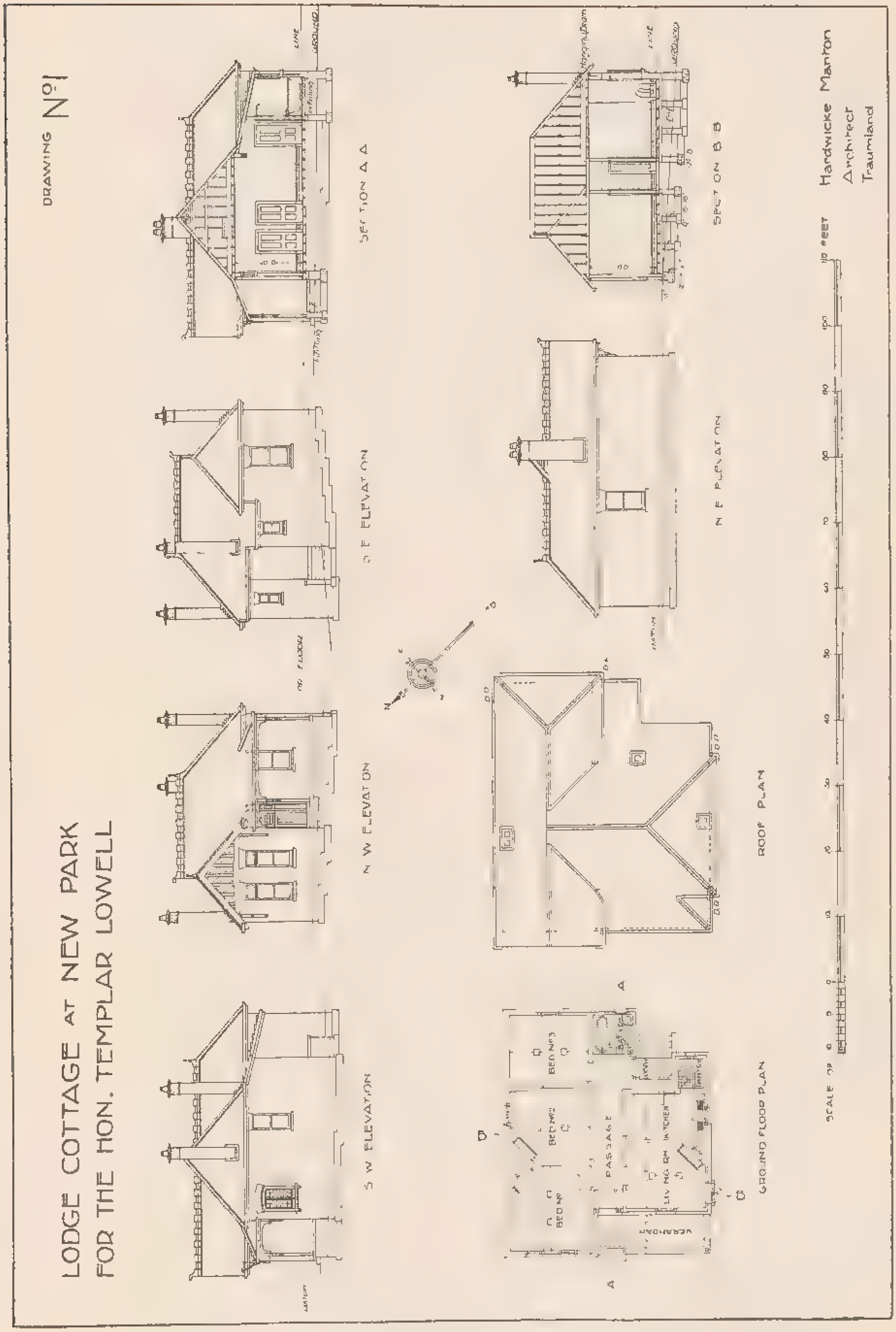
Inking In. The drawing having been quite finished in pencil, the inking in may be proceeded with, and here, at the outset, it is well

to remember how extremely important it is to practice cleanliness. Let pens be clean. A little water in which to dip the pens as they become dry and a piece of linen rag on which to wipe them, will secure this. It is also important to watch the ink and keep it corked, otherwise, if exposed to the air, it becomes stale and thickens. The feeding device in the bottle is good, and saves the old-fashioned habit of dipping the ruling pen right into the ink, and wiping the outer surface. The feeder, however, should be kept clean, and not allowed to dry.

For the process of inking in an architectural drawing, the following may be taken as a valuable practical rule for procedure. Ink in all hand work first, then all circular work, and lastly the straight lines. Begin, therefore, with the nib pen, and carefully put in all hand curves, then all figuring, lettering, &c. Afterwards any curves requiring the use of "French curves." Then turn in all circular lines, and lastly rule in the straight work, remembering the all important rule of keeping every line on the sheet of one value and thickness. The actual thickness of line should at the outset be determined upon, and this may be "thin," "medium," or "thick," according to the fancy or the temperament of the draughtsman, but whatever thickness is set as a standard, that standard should be adhered to throughout the drawing or the set of drawings. For dimension lines use a thin red line, as also for any "datum," "centre," or "working" lines not necessarily a part of the actual building. Show soil drains also in red, and any special notes that require extra prominence. Storm water drains, rolled steel joists, as also the plotting of all old work upon the drawings, are best shown in blue ink.

Coloring.—When the inking in has been fully completed and the sheet well looked over, proceed to clean off all superfluous pencil marks with soft rubber, being careful not to rub too hard, or the surface of the paper will be injured for coloring, and the lines made rotten or broken. To take general dirt from the paper, bread may be used with advantage.

PLATE III.



LODGE COTTAGE AT NEW PARK
FOR THE HON. TEMPLAR LOWELL
DRAWING No 1
S W ELEVATION
N W ELEVATION
S E ELEVATION
SECTION A A
N E ELEVATION
SECTION B B
ROOF PLAN
GROUND FLOOR PLAN
VERANDAH
LIVING RM
PASSAGE
KITCHEN
SCALE OF FEET
Hardwicke Manton
Architect
Traumland

The various materials indicated upon the drawings are now to be made doubly clear by coloring, and for this purpose the following list of materials, and their representative colors, may be taken as a guide :—

Materials.	Color.
Wood floors	Yellow Ochre (light).
Tiled floors, hearths	Crimson (very light).
Tiled roofs	Neutral Orange.
Asphalt floors	Payne's Gray.
Stone steps, hearths, sills ..	Prussian Blue (light).
Brickwork (surface)	Venetian Red.
Brickwork (section)	Crimson and Venetian Red (half and half).
Terra-cotta—red	Vermilion (light).
Terra-cotta—buff	Yellow Ochre.
Woodwork (unwrought) ..	Gamboge.
Woodwork (wrought) ..	Burnt Sienna.
Slates to roof (green) ..	Yellow Ochre and Indigo.
Slates to roof (purple) ..	Indigo and Crimson.
Ironwork (including gal. iron) ..	Prussian Blue.
Concrete	Neutral Tint.
Earth	Burnt Umber and Crimson.
Lead	Indigo.
Plaster surfaces	Yellow Ochre and Indigo (light).
Cemented surfaces (plain) ..	Payne's Gray (light).
Cemented surfaces (rough cast) ..	Speckled in Indian Ink with pen, and left white.

Select the light washes first. Rub up the colors upon clean china palettes in a very small quantity of water, and then add more water, and try on scrap paper till the required density is obtained, then proceed to lay the color on the drawing, taking care to set the board with a slight tilt forward so that colors may run downwards, and not lie in puddles. Keep a fairly full brush, and do not allow any part to dry till the whole wash is laid. When one color is laid over the various parts of the drawing, let it dry, and proceed with the next color, making it a rule to lay down all light colors, and especially all washes of large surfaces, first, leaving section and all other dark parts until last.

For sectional work the rule is to indicate by darker color than that employed where surface only is indicated. This may be supplemented in the case of details by "hatching," that is, scoring across the sectional parts with freehand lines at an angle of 45 degrees.

Details. The preparation of details is an important part of the draughtsman's task, a task, however, which is hardly considered within the capacity of a beginner, as the proper delineation of the special parts of a building must needs require mature knowledge. Measuring up old work, drawing out constructive details, and observing actual work will, however, greatly assist the draughtsman in this class of drawing, which is best done on sheets of cartridge paper to the larger scales hereinbefore mentioned.

For purposes of showing elevations in detail, a ½-in. scale is a good workable one, for the workman can then take every half-inch on his ordinary two-foot rule as representing a foot. For fittings and smaller objects with many breaks and lines, the 1-in. scale will be found better, while the 1½-in. and 3-in. scales are often also used.

All moldings, special features, and ornaments should undoubtedly be shown full size, and this is best done by drawing in, firstly, with charcoal (which may be dusted off), and then hardening with bold BB pencilling. A free use of the large color brush and monochrome color is a great assistance in the delineation of raised ornament, as also is modelling clay or "plasticine" to show intricate intersections. In detailing, the labor of inking in may often be dispensed with, it being sufficient if the drawings are neatly made in pencil and fixed by light coloring.

Tracings.—To make neat and accurate tracings of original drawings is one of the necessary qualifications of the draughtsman, and, in the practise of this, he will be enabled to pick up many hints, both of planning and method, against the time when he himself is entrusted with the preparation of original work.

Tracing is either done on linen or paper.

Tracing linen is the best for copies of working drawings in cases where the contractor has to use them in all weathers when carrying out the building work, for in this way they have to withstand a great deal of wear and rough handling.

To see tracings in use upon a building in rough, windy, and showery weather, before the work is covered in, is to understand the need for tough and wet-withstanding tracing linen and indelible ink.

To make a linen tracing, cut off from the roll sufficient linen to cover the drawing to be traced, and work on the unglazed side. Carefully and very firmly pin down, as the linen tends to flabbiness with working and changes of weather. Pounce the surface of the linen with powdered chalk or cuttle fish powder, or rub over with soft rubber, so as to enable the ink to grip the linen. In using chalk, wipe off all superfluous powder, otherwise it will clog the pen. Proceed exactly as already explained for inking in drawing. Keep to a dense, even line, hand work first, then circular work, and lastly straight lines, taking great care not to smudge the work, and remembering that ink on linen takes longer to dry than ink on drawing paper. First, when coloring, add a little soap to the color to help it to lay freely, and color, for the most part, on the back glazed side of paper, using the face or unglazed side for sectional parts or small pieces of coloring that need to be specially brought out with greater clearness.

Ink paper tracings are done in the same way, but without need of pounce. The coloring for this medium should all be done on the face.

For pencil tracing, which is often used for duplicating details and large scale drawings which only have a short time to wear, a good unglazed paper is best, used with a medium pencil, not soft enough to make a woolly line, nor hard enough to cut the paper. For this work, too, the draughtsman may, with advantage, use a chisel point to the pencil—*i.e.*, a point sharpened flat-wise, useful in putting in long, straight lines, the round-pointed pencil being used for other parts.

On tracing papers it is best to avoid coloring as much as possible, as water tends to cockle up the paper and distort the scale and lines.

Duplicating.—There are various ways of duplicating drawings other than by tracing, such as by lithography, which may either be done by laying a specially prepared tracing, drawn with grease ink, upon lithographic stone, or by obtaining a transfer for the stone, by means of photography, from the original drawing before it is colored. This is the cheapest process when a very large number of copies is required.

Where a limited number only is required there is a process, now being worked, whereby the original drawing, before it is coloured, may be sun-printed and *fac-simile* copies taken off, when the original and the copies may be colored together. An intermediate process is to sun print, on to helio paper, from a linen tracing. Copies may also be made from linen tracings (uncolored) by sun printing and blue prints produced, but, as these cannot be colored, they have this disadvantage for architectural work.

Mounting.—The draughtsman may sometimes require to mount his drawings for special purposes of display, such as for competitions, or he may prefer working upon mounted drawing paper rather than upon sheets simply pinned down. In some architects' offices the old rule still prevails of mounting the paper for all working drawings. This secures a tight and smooth surface without the obstruction of pins, and only has the disadvantage that the sheet cannot be removed from the drawing board till the completion of the drawing. To mount a sheet of drawing paper, lay face downwards on a clean table and wet well the whole of one side of the paper, allowing the water to fully soak in and charge the paper, without being too sloppy. Then with blotting paper lightly dry off the edges for about one inch all round the sheet, after which proceed to glue all round the extreme edge of the paper. Turn the sheet over quickly and lay it on the drawing board, then pull out tight all round, and firmly rub down edges;

leave to dry (all night is best) in a cool place, and when dry the sheets should be found taut, smooth, and hard.

The same procedure can be gone through in the mounting of drawings, for display, upon stretchers, which are simply frames of deal, generally about 3-in. by 1-in. scantling, covered around the actual drawing with suitable colored paper. In this class of mounting, the stretcher is best covered first with cheap calico, otherwise there is danger of the drawing being broken through in handling.

Perspective.—Although perspective drawing does not come (for want of space) within the scope of this treatise, the student may be directed towards its study, which will be found fruitful in both profit and pleasure.

To draw a building in perspective is to set up from the geometrical drawings a picture delineating how the building will appear to the ordinary lay spectator when actually built. Such an art is of the greatest value to the designer, for it enables him, not only to test the effect of the various parts of a design, but also to convey to the layman a representation of what he is to expect in the proposed building.

CHAPTER III.

PLANNING AND DESIGN.

THE questions involved in planning and design are those that embrace the distinctly architectural difficulties of the designer's art, and must be approached with due consideration to the importance of the decisions to be arrived at, remembering that the building has to be built in the mind's eye ere it can be built in actuality.

Further, a building should not be considered primarily as a "plan" only, though the plan is, and should rightly be, considered as a very important part of the whole; but a building should be thought out and designed very much in the same way as a modeller builds up an image in clay—not in plan, nor in section, nor in elevation, but in mass, and as a whole, an entity. To do this successfully, some maturity of mental effort and technical skill will be found necessary, but, if the simpler problems of design be first of all approached in this way, and successfully mastered, the way to larger and more intricate schemes will be made easier and plainer. What is all-important is to begin right, and to save the labor of unlearning false methods before commencing the learning of the better ways.

It is a common error to suppose that it is fairly easy to make a "plan," while a designer's skill is necessary to produce an "elevation." The two should not be disassociated, for planning can only be successful when it works in true harmony with the whole building; the building of mass, of breaks, windows, heights of apartments, roofs, perspective, balance, color, and the rest.

The skilful designer holds in his hand the possibilities of lasting fitness and beauty, when it is remembered how mass and line may

be made to express the varying sentiments and emotions of the man, such as solidity, balance, truth, aspiration, movement, mystery, rest, and so on.

What is more typical of solidity than the granite walls of ancient buildings, or more dignified than the stately classic columns, which vie with each other and with the beauty of entablature and arcade to suggest the balance of truth; while the elongated clustering of uprising Gothic shafts lead aspiring thoughts to the mystery of groined roof and the rest of the old cathedral shadows.

Yet truth is not confined to these things. It may lurk in a kitchen chair as much as in a shrine, and simplicity is not incompatible with beauty.

Color.—Color should also be remembered as being an important factor in design, and its harmonies studied and allowed for in building design, for its possibilities, both outside and inside a building, are well nigh limitless, and may be used with great skill as a part of the design.

Modern Hygiene.—In remembering, however, the importance of these things, full consideration must at all times be given to those great laws of modern hygiene, which should be embodied in every new building, for, if beauty of form and color are necessary for the pleasure of man's emotional nature, so are the more material elements necessary for his well-being and health.

Our building should at the outset, therefore, be "healthy building." To this end it will be found that building laws are made and administered by city and rural councils and health authorities, and these laws as a rule may be taken as tending in the direction of creating a healthy standard, wherewith to conserve the mutual interests of gathered communities; and in most of his building the designer will find that the work has to conform to certain of such requirements, the scope of which should be

ascertained from the proper authorities, when any new building work is in contemplation.

That health is the vital principle of normal life we should remember, and so build as to bring into harmony the laws of well-being, which science has revealed to modern practice. These laws, given briefly, may be enumerated as the necessity for healthy building sites, proper protection from the weather, uncontaminated air, sunlight, and pure water supply; and the all-important need for the proper removal of all wastes by drainage, cleansing, ventilation, incineration, &c. These requirements, therefore, should enter into the warp and woof of modern building, and full consideration and value should be given to them when new building schemes are being formulated.

Under these hygienic laws the question of site should have at the outset very careful consideration; and, speaking of building sites, it will at once be apparent how the exigencies of business will determine the site of business premises without regard either to aspect or healthy conditions, and often in positions that offer considerable difficulties to the application of the best laws of hygiene. Still, where possible, even these business sites should be chosen where reliable weight-bearing and dry subsoil foundations may be established, and it should be remembered that the earth is always more or less charged with both air and water, which fact has to be allowed for when considering the site for new building work.

Impervious Ground.—The ideal site for building is undoubtedly the impervious site, either natural, such as rock, or made impervious by artificial means; but so existent as to offer an impervious surface under the building, so that neither ground air nor excess of moisture may be drawn out of the ground to injure the building, the goods stored in it, or its tenants.

House Sites.—In seeking the site for a dwelling-house, the

difficulties that are characteristic of the Old World, such as overcrowding, contamination of soil by former usage, made ground, and other causes, that enter more largely into older and more densely populated lands, are to a very great extent absent from our midst. Therefore, from the virgin soil and broad openness of a new country, the choosing of a site is much simplified. Yet the subject is, even among us, one of very considerable importance, and profitable time may well be given to the consideration of the requirements of a good site.

A good site should undoubtedly be in a good climate, though business considerations will generally determine the locality, if not the place, in which a man must build his house; but, given any climate, the site should be so situated as to avoid, as far as possible, the disadvantageous elements of the prevailing weather, while securing as far as may be its advantages. For instance, in one case there may be a furious hot wind to be avoided, or in another a refreshing afternoon breeze to be wooed.

A site should also be dry. To build on spongy, ill-drained land is folly, when it is remembered that such dampness is highly injurious, and tends to pulmonary and rheumatic diseases, if not fevers and other ills. In fact, any ground water under a building may be taken as very strictly to be avoided, and the best sites are those which are upon more or less well-draining soils, and which allow the natural rainfall to drain away, and thus keep the ground water well below the surface.

For this reason, and for the general reason of drainage, low-lying sites should be avoided, for such sites not only contain the natural soakage from higher lands, but present, in many cases, considerable difficulties when the question of waste water drainage has to be considered.

A clay subsoil tends to hold ground water, and, if chosen, should be drained by agricultural pipes or by other suitable means, otherwise it is certain to be highly charged with water in the damp seasons, and, for this reason, prove unhealthy, especially when

under the artificially created influences of the heat of the house. Sandy soils or those containing gravel subsoils are generally among the most healthy, but elevation of general position should be chosen, and if the site in itself has some fall, it should be better than flat land for many reasons; first, because surface drainage is more easy to carry from naturally falling surfaces, and secondly, because, both with house and garden, greater picturesqueness can be obtained from undulating slopes than from level plains.

In sites for terrace houses the question of garden culture enters but a little, if at all, but with the great field of villa and country house building before us, the claims of the garden are worthy of consideration, and it may be said that the healthiest soil upon which to build a house is not always the most congenial for the planting of a garden. In this the designer will have to choose which most to consider the health of the garden, or the well-being of the dwellers in the house. Perhaps, by some skill of labor, both may be successfully compassed.

A plea may here be put in for adequate spacing in house sites. The land should be chosen to offer adequate space around the building, so as to avoid the many objectionable features that must accrue when the land is too far overspread with the building, not only for reasons of light and air, but also for accessibility and for the avoidance of overlooking from the windows and doors of one house to another. If a house and garden are to be designed as a "home," each tenement should have the elements in its composition that tend to self-containment, untrammelled by pinchiness of site.

A site should, therefore, be chosen adequately large for the building that is proposed to be erected upon it, and the apartment accommodation roughly worked out before the land is decided upon.

With the site chosen, and the accommodation of the proposed house enumerated, we may proceed to the consideration of those principles which affect the design of the structure.

Material.—The question of material must first of all engage careful attention, for it is with a chosen site, fixed requirements, and available material that the designer has to do. Local conditions will greatly affect the materials to be used, for, as a rule, in brick-producing districts it will be found advisable to use the local article for the walls; if stone, then stone; or, if wood be available and in abundance, then timber houses may be made both practical and picturesque; or, in districts where materials such as these are not readily available, building by means of concrete blocks may be resorted to, if rock, scoria, or gravel be found, but whatever may be the main wall material chosen, it should be treated honestly, and the house so designed as to show out the naturalistic treatment of whatever material is used.

After determining the general wall material, the roof covering is the next in importance, and this may be of tiles, slates, iron, shingles, or any of the manufactured coverings upon the market. The structural timbering, floors, finishing woods, &c., will all be determined by local conditions and available funds.

Plotting the Site.—Before commencing the design of the house, the site should be plotted upon drawing paper—for instance, to a sixteenth scale, having the levels shown in contours, so that the falls can at once be seen at any point of the land. The four points of the compass should also be accurately determined, and a careful note made of the juxtaposition of adjoining buildings (if any), and specially with regard to their doors and windows. A note should also be made of any natural views, or specially advantageous outlooks, which may be taken advantage of in the planning.

All these things should be laid down before any design for the building is commenced.

Now, laying aside all ideas of a house design being produced like a suit of ready-made clothing, just like some other house, that may fit, or may not, but in any case is doubtful, and almost certain to

break down in some important particular, determine first the general size of the apartments required, and the best aspects for each apartment with regard to sunlight, morning and afternoon light, coolness, heat, wind, dust, accessibility, and so on, and planning in the light of these the designer will realize that his work has begun.

In the chapters upon "Houses" we will pursue this subject further; sufficient in this that we here lay down the general principles which should be followed in house as in all other planning. We would do well here to consider briefly a few general questions of architectural designs, as they may affect the ordinary work of the designer.

Plan Mass.—It will be found that but limited progress may be made in "planning," before it is seen that, owing to the exigencies of properly lighting the apartments of a building, certain mass forms shape themselves in certain fixed ways that may, for the purpose of study, be broadly grouped together; such, for instance, as the ordinary rectangular mass of the one-story house upon a narrow allotment of land, or the L-shaped plan, in larger houses, where the servant's apartments and kitchen offices are cut off somewhat from the main mass of the house. The H-shaped plan, or its modifications, is another common form that planning takes upon itself, especially with institutional buildings upon open sites.

Then, again, there are the many high city buildings that have to depend upon front, back, and top light only, and these naturally group around the breaks required for light areas. Churches with their cruciform plans, and other special buildings generally tend to characteristic plan forms.

All these types require special and differing elevation and group treatment, and the student would do well to study examples of actual buildings where these problems have been dealt with, both in ancient and modern buildings, as around problems such as these are demonstrated the subtle balance of successful design.

Height Mass.—The determination of the height of a building in a design is also of very great importance, and presents in Australia many difficulties which are only casually touched upon in other countries. Our preference for a one-story treatment of the greater number of our dwelling-houses requires special and peculiar group treatment, but limited precedent for which is found in other lands, and upon these lines we may look for interesting developments as the years reveal the working out of our own domestic architecture; but whatever the character of the building may be, its treatment of mass, the position of conspicuous features such as gables, towers, bays, oriels, roof masses, &c., should be considered in the balance of the whole, remembering how unsuitable such features may be made if not applied with that nice sense of true balance that all successful design requires.

Height Grouping.—To lay down definite rules for this height grouping would be most difficult, although, with a sense of its paramount importance in architectural composition, several writers have endeavoured to lay down more or less accurate mathematical rules for dealing with the subject, and have endeavoured to read into the compositions of successful designs certain laws of proportion and balance, just as in painting and pictorial compositions (for the purposes of teaching) laws have to be formulated which may help to guide the student.

Yet it is more likely that the great masters of art instinctively felt the true balance of their designs, more than the fixed rule of mathematical accuracy. Still, to follow these rules is not without profit in acquiring a working knowledge of design.

Style.—Design grouping is intimately affected by "style," and the student, by his history studies, will understand the leading characteristics of the various styles of architecture, and, in his own work, will doubtless be influenced more by one style than another, according to the largeness of his knowledge and the quality of his

temperament; for architecture must needs be to a great extent an imitative art, even though, to a degree, it should be a creative one.

To work within the limits of some chosen style, when designing a building, is, therefore, the usual way to proceed, and here precedent will be found very strong. The British are a conservative people, in spite of liberal institutions, and rightly display in their architecture that love for the old forms, which have become indestructibly interbuilt into their national architecture, and these forms and precedents find their reflection in the distant lands of their colonization.

To see the best examples through our own eyes, and to use as much or as little as best suits the proper purpose of our own building, should therefore be our object.

Certain styles have, by the usages of years, become identified with certain classes of building, and this, in a measure, is often good reason for their re-adoption, with those modifications that suit the to-day requirements—for instance, the various forms of Gothic find much beauty of old association for church work, intermingled but slightly with the round, arched Romanesque of the early Church. The classic styles of Greece and Rome, both in their pure interpretation and in modified form, have graced our public and semi-public buildings for all time, and form a dignified and massive *motif* for a national type of composition, suitable for large and extensive buildings of a monumental character.

Britain of all countries, too, is rich in the beauties of house architecture. Truly a country of homes, she offers endless fields for study and suggestive ideas in domestic architecture, as her ways have wended through the many years of her ever-changing *régime*. First through rude Saxon to the great feudal castles of the Norman invaders, whose massive walls even a thousand years have scarce destroyed. There moat and drawbridge lie, but as an unused image of a past necessity, that must needs give way before the incoming of the greater English liberties, which brought with them

the stately mansions of the renaissance, and the quaint half-timber houses of the people.

The three great styles of Gothic (the early English, the decorated, and the perpendicular) that lie so closely to the heart of architectural England will always inspire the designer of British stock, while, if the gorgeousness of Eastern art and the quaintness of foreign manners in building may charm for a time, and influence here and there, their strict reproduction is not sufficiently to the public taste to find anything like general acceptance.

Then there are the great fields of modern building the world over to be studied, where varying conditions and natural characteristics are constantly influencing the styles adopted, such as the tall American business buildings, and the adaptation of certain forms of construction, such as steel framing or armoured concrete, or the working out of new *motifs*, such as the new art now being developed in Europe.

From even this casual review, it will be seen how wide is the designer's range of selection for ideas, yet, when he has glanced through all these styles, he will see how little is actually suitable to the requirements of Australian practice.

The adaptation of style should be carefully weighed by the designer, who will generally find it best to consider each building problem distinctly upon its own peculiar and separate merit, and, having in mind what we have before enumerated of site, aspect, accommodation, climate, and cost, so design as to treat the building in what may be defined as a naturalistic manner. In this way, and in this way only, may we look for true development in our national architecture, free, on the one hand, from slavish copying, and showing an awakening towards such designing of mass, parts, and ornaments as shall best bring forth that conformity with truth which makes for great architecture.

To strain merely after style is but too often to miss the highest, while to allow the style to grow out naturally from honest construction is better.

Side by side with mass balance should be the securing of continuity in the various external parts of a building composition, a certain threading together of the various features, so that one is an essential part of the other and of the whole, and so that no one feature may look "stuck on" or superfluous. The use of string courses, bands, vertical shafts, and other line-forming devices often helps in this particular, while care should be taken to so design verandahs, porches, bays, and any large projections which occur on the general body of the building, that they may be felt to be an integral part of the whole, and not look as though they could better be dispensed with. In securing this "continuity," it will be found that color and material will play a not inconsiderable part, for disconnection is often the result if the projecting mass be of a different material from the main mass, such as where a weatherboard addition is made to a brick building, or a flimsy verandah is built up against a solid building without any structural clenching.

To make a design homogeneous is to make for success.

Sky-line.—One is often impressed with the important value of "sky-line" in building. In the fine clear skies of Australia, where the eyes of men are lifted more to the blue than where the murky skies of colder climes have to be reckoned with, the value of the sky-line is of added importance, and, certainly with detached buildings and with buildings occupying high or commanding sites, this consideration offers good opportunity for design, and should be duly weighed, remembering that even with pleasing roof massing and well-designed chimneys much may be done; and if with these smaller buildings beauty is obtained, what may not be done with large public and semi-public buildings, where tower and spire and cupola may help the effect?

Ornament.—Architectural ornament is an important part of design, and, together with moldings and features, goes largely to make up the character of good work.

In outside ornament certain factors which do not govern interior ornament enter. These are mostly considerations of weather, exposure, direct sunlight and shadow, and these, in their turn, affect material and treatment. Ornament should, however, always be applied with restraint, and, as far as possible, in conformity with the constructive character of the building, for nothing can be more fatal to successful ornamentation than its excess. The eye needs repose, and the plain surfaces should be designed with as much care as ornamented ones.

It is well to observe how very vitally strong sunlight, and consequently the strong shadows, will affect the appearance of a building, and all external ornament should be designed with this principle in mind. The great beauty of cast shadows, when the constructive masses are well balanced, is often almost all-sufficient in a country such as Australia, where only those ornamental features should be used which conform to these conditions. Cold, wet, frosty, snow-laden climates have brought forth in building, molding, features, roof slopes, projections, ornaments, and forms to counteract the worst effects of such weather, or to bring out the best effect possible, so that in a temperate and sunny climate like our own the treatment should be different, and should be directed to suit our peculiar circumstances, where the sun should be allowed to do all it can towards the ornamenting of our building.

We should seek, too, to avoid meaningless ornament, or the placing of any ornamental work upon a building without having corresponding constructive value.

Ornamental Motif.—All ornaments must have some *motif*. There is the religious symbolism of the Egyptian wall ornaments, the exquisite carvings depicting the doings of gods and men upon the friezes of the Greek Temples, repeated in a measure by the later Romans. The entwining of the lotus, the honeysuckle, and the acanthus; the masks of men and animals, and later the influence of these old classics repeated and blended in the

renaissance. Then there is the vast field of Christian and religious symbolism, all affecting architectural ornament, so that it will be seen that each building must be considered, in its ornament as in its general design, purely upon its merit, and some suitable *motif* be adopted, through which should thread the scheme of general ornamentation. For ourselves, we may certainly turn with profit to our own Australian flora and fauna to supply *motif* for such of our ornament, and, by learning the best methods of their treatment for this purpose, to so select and conventionalize what is before us as to adapt many of these distinct and beautiful forms to the ornamentation of Australian buildings.

Ornamental Distance.—Ornament must always be designed with true regard to its normal distance from the eye, that which is near being capable of high and often minute finish, while distant objects are the better planned with boldness, both of conception and projection. For this work, some training in modelling is of very great assistance to the designer, who may with profit take a course of actual practical work with the clay, which medium is fruitful in bringing out the points of mass and projection that constantly recur in the designing of ornament.

Another point worth remembering is the differing value of projection upon a small mass, as against a large mass with the same projection. This is constantly seen in actual work, such as where various groups of chimneys are allowed to have the same projection of molding whether they contain four or eight flues, the result being that the projection of the eight-flue chimney, if well balanced, only overweighs and makes ugly the four-flued chimney, especially at the corners, where the oversailing is most seen. The same principle applies to height. In cases where a chimney rises out of a ridge, its detail is often the same as a similar chimney rising from the eaves, with unhappy results to both, for every mass should have its own weight of molding, projection, or ornament, even though there may be master overhanging cornices that are common to the whole.

Interior Ornament. Interior ornament must be designed with different treatment from the external. In the absence of direct sunlight, diffused and artificial lighting only has to be reckoned with, while the sheltered character of the work allows of materials and colors which are not at all admissible upon the outside of a building being introduced. The questions involved in interior ornament are so closely identified with other subjects, to be afterwards specifically dealt with in this book, that it is not intended here to further enter upon them. Sufficient to say that all internal ornament should follow, in general treatment, the design of a building as a whole, and should be in harmony and general character with it; nor should the designer's work, in our opinion, be fully discharged before the building as a decorated and furnished and, if you will, garden-surrounded entity, be made by his overseeing skill complete.

CHAPTER IV.

SMALL HOUSES.

A VERY large proportion of building activity is always directed towards the erection of houses of moderate size, either for letting purposes or for individual ownership. These activities are most marked in the ever-expanding suburbs of the larger cities, as well as in those places where the closer settlement of the land calls for new and suitable houses for the people.

That each family should aim at the occupancy of a separate dwelling, however small, self-contained, and with its own land allotment and garden, is a laudable ambition, which finds favor among the ranks of the larger proportion of our population, and some hints may therefore be here given to show how best, and most economically, this class of building may be carried out.

The first quality that should be considered in house planning is "convenience," and this quality should thread itself through the various apartments of the house, and weave the whole together, so as to result in a well-balanced composition.

That a house has to be lived in by a given class of persons, by a given number of persons, and administered in a certain way, should be first before the mind of the designer.

Site, aspect, accommodation, and cost, therefore, are the first things to be determined upon.

Nothing can be worse than the growing tendency of building house property on inadequate allotments of land, where the building overspreads the site, to the exclusion of reasonable surrounding space, and which brings with it unwholesomeness and the annoyance of being overlooked by adjoining owners.

The site, then, should be adequate to the house, and the house suited to the site, and no house can be suited to a site without the aspect of each apartment being separately considered and planned, not as it happens to come in the plan, but with deliberate purpose and design. At the outset of house designing, the materials for walls and roofs must be determined upon, and the structure so arranged as to best suit the materials chosen. Every material has its possibilities, as every material has its limits, and every material should be treated in execution on its own peculiar and best arranged way.

There is the beauty of the timber house, as there is also the more substantial beauty of the brick house or the stone homestead. Where good building stone is available, substantial walling may be built in rubble work, and if cube stone be found too expensive, dressings of brickwork may be built fair at angles around door and window openings, and to chimneys and general finishing parts. This combination of masonry and brickwork is usually found satisfactory and reasonably economical.

For all general purposes, the best wall material for small houses is undoubtedly brickwork. Bricks, being small and uniform in size, lend themselves as a constructive material to small work, where breaks are frequent, and where the work is broken up into many parts, such as is necessitated by house-building. The bricks should be hard and sound in quality, and all external walls should be built with a hollow cavity, so as to keep out wet and equalize the temperature as much as possible.

Weatherboard houses may be made, by proper construction, sound and weathertight, but, while the initial cost of this class of construction is less than stone or brick, the life of the timber house is much less, while the cost of upkeep and painting must be considered as an important item in the maintenance.

For roof covering, tiles have many points of recommendation. If of good quality they are fairly cool, easily laid, weathertight, lasting, good in color, and, if of the Marseilles pattern, self-

ventilating. Their disadvantage is excessive weight, especially when wet, for, as a material, terra-cotta is more absorbent than slate.

Slates from reliable quarries, if well graded as to color, make very lasting roofs. They may, however, be classed as hotter than tiles, and special provision should be made for ventilating the roof spaces, as slates set close are non-ventilating in themselves.

Galvanized corrugated iron roofing may always be relied upon for resisting the rainfall. It is, however, the hottest of all roofing for summer use, though it cools off quicker than tiles or slates when cool changes occur. Iron is also the lightest, and, for this reason, requires less roof timbering than other coverings. For its appearance, its use is, however, not recommended in good class work.

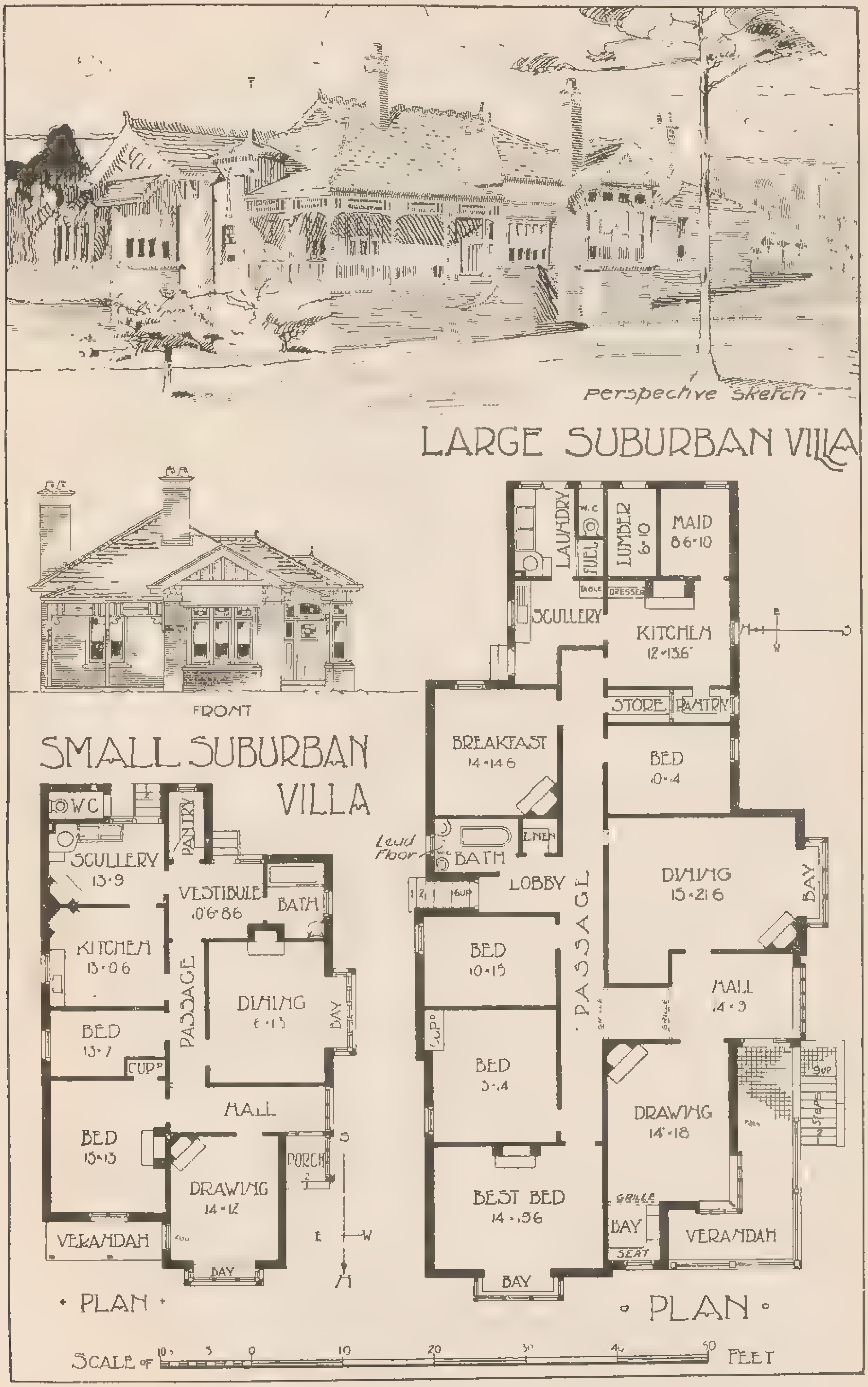
Shingle roofing is very pleasing in appearance, and, if of split peppermint gum, may be made extremely lasting. The danger from fire is, however, a serious disadvantage, which has led to the prohibition of this class of covering within certain town areas.

Suburban Houses.—It is with the suburban villa that the greatest house-building activity will always prevail, and there good work and bad will the most commingle with the sway of popular taste, and the come and go of styles, mannerisms, and modes of life.

That in suburban house building there is great opportunity of reform, as there is also equal opportunity to do good work, there can be no doubt, and much should be said and demonstrated towards bringing out that sound logic of naturalistic building, which may, by its sound and lasting reasonableness, leave no place for the unsoundness of the common manner.

True building, in the houses of the people, should be directed, as far as possible, towards two ends the creation of homes and the encouragement of continuity.

The first includes much, and has its constructive and practical building side, as it also has its ethical side. Home means con-


Perspective Sketch
LARGE SUBURBAN VILLA
LAUNDRY
W.C
FUEL
LUMBER 6·10
MAID 8·6·10
TABLE
DRESSER
SCULLERY
KITCHEN 12·13·6
STORE
PANTRY
BREAKFAST 14·14·6
BED 10·14
Lead Floor
BATH
LINEN
LOBBY
PASSAGE
DINING 15·21·6
BAY
BED 10·15
HALL 14·9
BED
DRAWING 14·18
STEPS
BEST BED 14·15·6
GRILLE
BAY
SEAT
VERANDAH
BAY
· PLAN ·
FRONT
SMALL SUBURBAN VILLA
WC
PANTRY
SCULLERY 13·9
VESTIBULE
BATH
KITCHEN 13·0·6
PASSAGE
DINING
BAY
BED 13·7
CUPD
HALL
BED 15·13
PORCH
DRAWING 14·12
VERANDAH
BAY
· PLAN ·
SCALE OF FEET

venience for a house. The basic idea of shelter, with all that it includes, should be present, and this is not possible without that planning, arrangement, and structural completion which finds itself in tune with our truly Australian conditions of life.

That our work has been all too temporary, too transient, too showy, frothy, unsuitable, and lacking in many sound qualities that are necessary for this continuity, we must all see.

To bring in, therefore, that which is better, to plan with reasonable restraint, and with logic and a sound use for each feature, and above all to induce that simplicity of taste, and appreciation of plain, honest, true material, rather than showy shams, should produce betterment, in a special degree, in our suburban houses.

In suburban houses the plan generally shows a tendency to lengthen towards the back, the sides of the house having to be close contained to give side spacing in the garden.

A reasonable amount of breaking up in the plan is allowable, and is an improvement upon the old-fashioned box plan, with apartments on two sides of a straight through passage.

On Plate IV. a compact plan of a small suburban villa, of moderate size, with a northern aspect, is shown. There is a side approach porch to the front door, screened from S.W. rains, leading to a little hall, with a stained glass window at the western end. The drawingroom is conveniently off the hall, and in close touch with the front door, so that casual visitors may directly approach, without traversing the house.

The diningroom faces west, and has a square bay, with an outlook south and north up and down the garden. The kitchen is across the passage, with an eastern aspect, and with a scullery, fitted with copper and wash-troughs, opening off. The pantry is planned south for coolness, and is off the back vestibule.

There are two bedrooms—the larger with northern aspect, which is a pleasing winter aspect, and the other having an eastern light.

A front elevation is given, showing general grouping and roof lines, with ceilings 10 ft. 6 in. high. There is a pent screening the

drawingroom bay from the high northern sun, while the verandah screens the bedroom windows. The roof is ventilated by louvred gables near the ridge.

On the same plate (No. IV.) is shown a large suburban villa, which faces west, the land falling somewhat steeply to the front, which helps the general effect. For this reason the approach is up a flight of outside stone steps, on to the verandah, and thence through a side door to the hall, from which drawing and dining rooms both open direct, an arrangement which works well in case of entertainments, when the three apartments may be practically thrown into one. There are three bedrooms grouped together upon the northern side, with a bathroom and linen store, and a side door to the garden from the lobby.

There is a breakfast-room with eastern morning light.

The kitchen has a cool southern aspect, with a window well arranged in relation to the range. The pantry and lock-up store is also south.

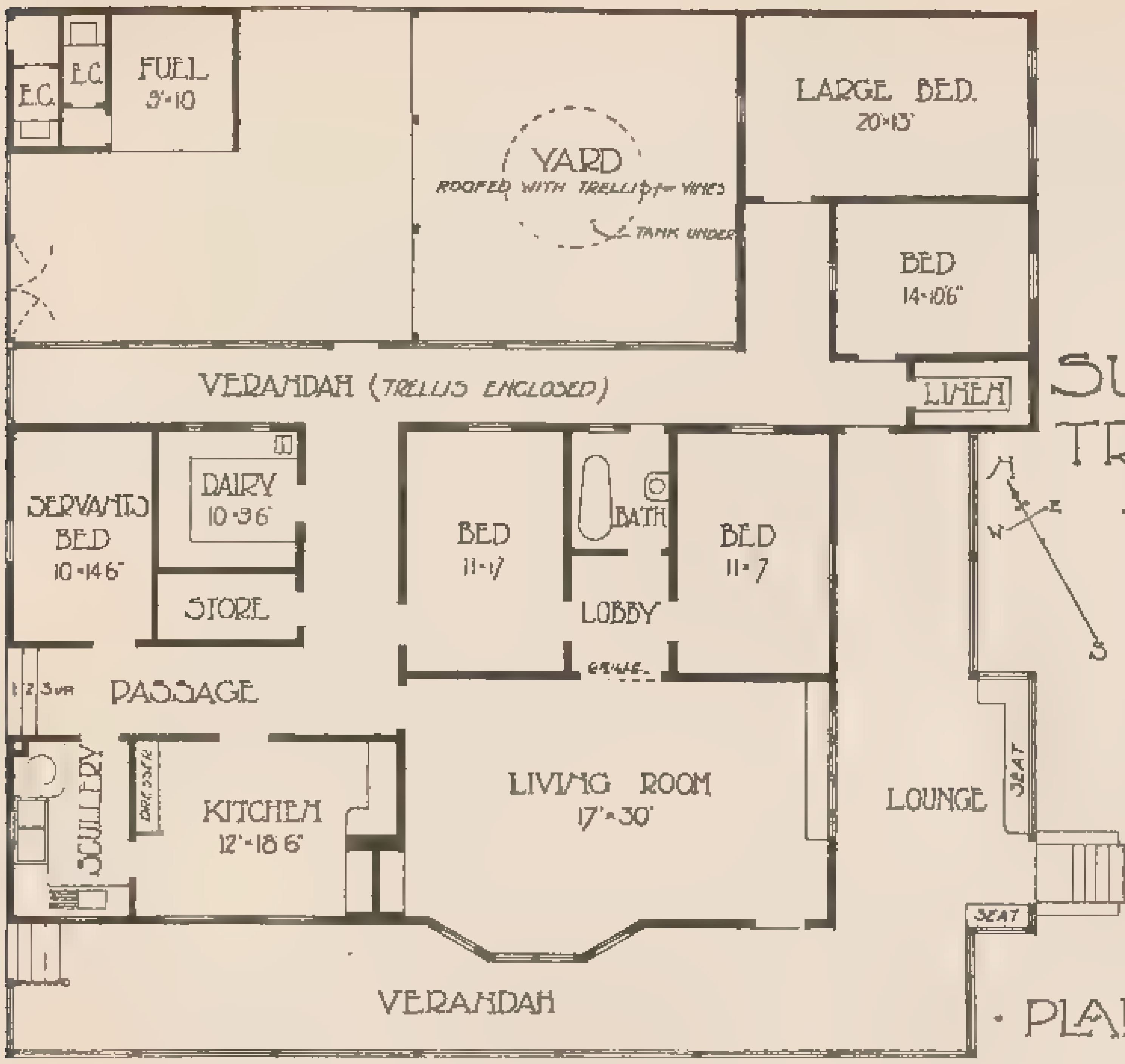
There is a very good arrangement of scullery, laundry, and fuel at the north-east end, as also an outside lumber-room and W.C.

The perspective sketch shows the general grouping. The house is of brick, with a tiled roof, and wooden verandah treatment, the ceilings being 11 ft. high.

A modification of these plans is shown in fig. 1, Plate V., where the hall is made large, so as to serve as a sitting and living apartment. This has many points to recommend it, not the least of which is the saving of passage room, for it must be remembered that passages in a plan often occupy valuable space, and cost quite as much as the same superficial area thrown into a room. The object, therefore, of planning, as far as possible, without passages is to be encouraged.

Where a verandah is interposed, as in this case, between the approach and the hall itself, that crudeness, noticeable when a street door opens directly into a dwelling-room, is not here perceived, and such an apartment as is here shown may, with

PLATE V.



SUB TROPICAL VILLA·

FIG. 3.

· PLAN ·

COMMOM ROOM VILLA·

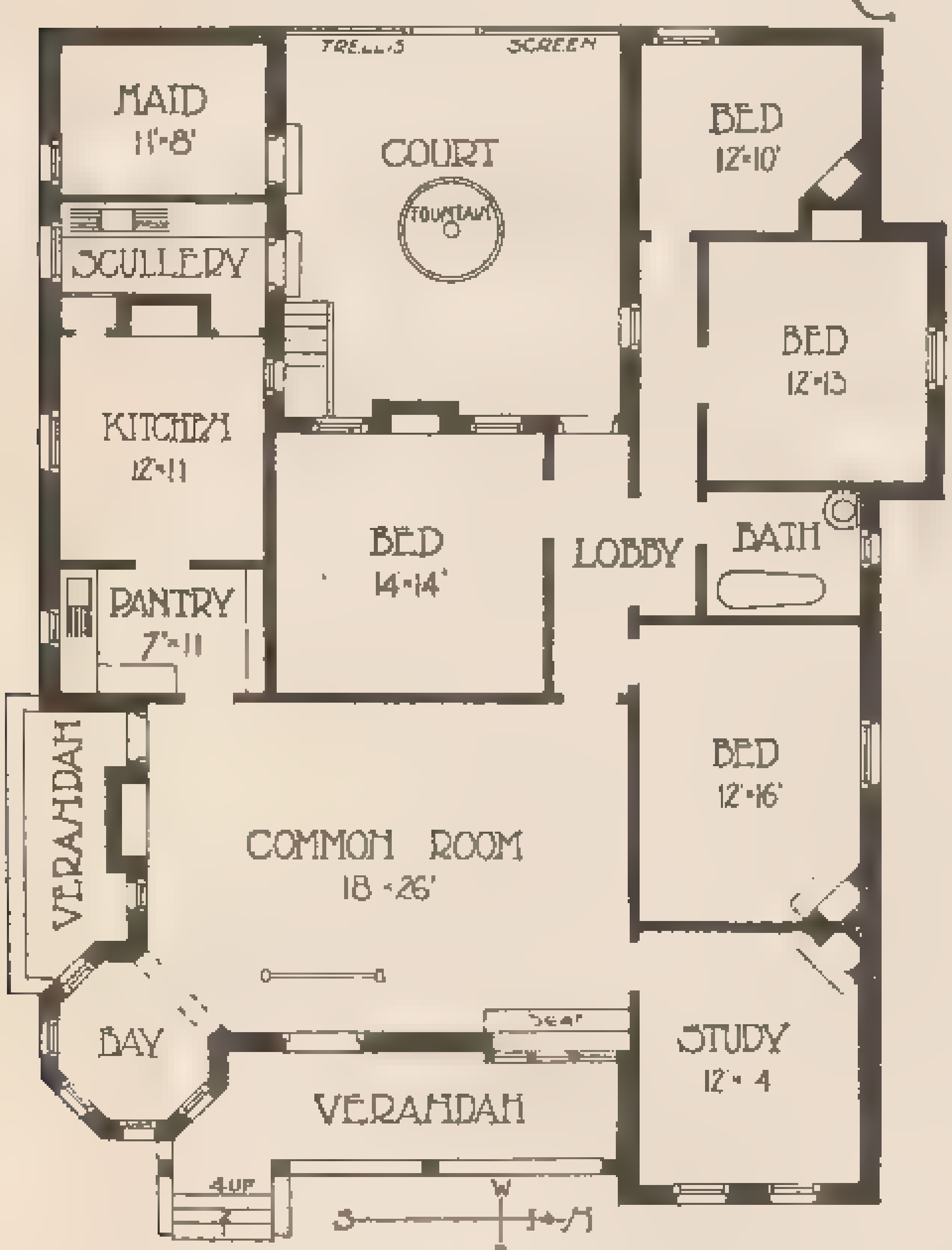


FIG. 2. · PLAN ·

WOOD VILLA

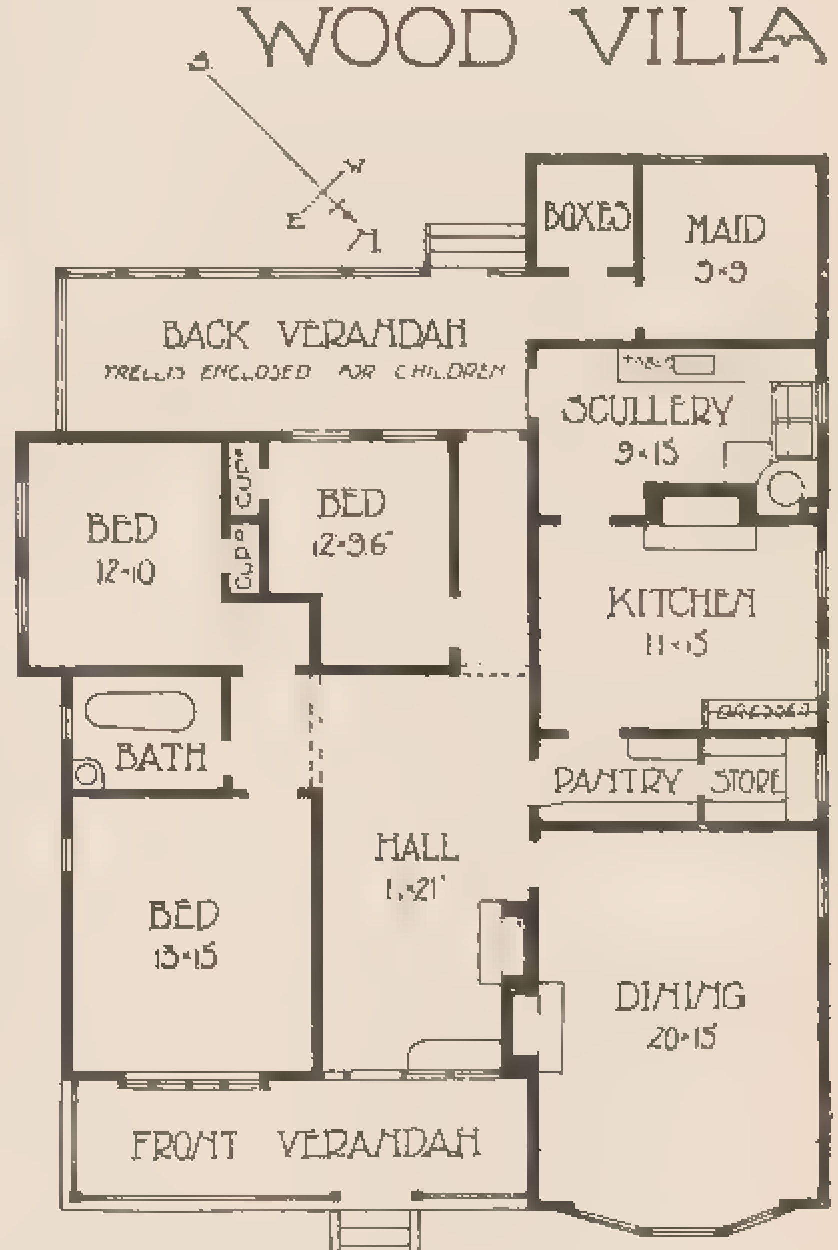


FIG. 1. · PLAN ·

SCALE OF 10 5 0 10 20 30 40 50 FEET.

window seat and fire-place and the adequate space given, prove a pleasant apartment.

In this plan the diningroom is in the front, and the other apartments are grouped at moderate distances from the hall.

Common Room Villas.—Much may be said in favor of an arrangement of apartments, differing in somewhat marked degree from the general villa, in that one large living or common room is built to do the work generally assigned to the drawing and dining rooms in an ordinary villa.

It will at once be seen that by giving up the superficial area of these two apartments, and the passage or hall that generally connects them, and throwing this space into one large apartment, a fine spacious and open room is created, of a size but seldom seen in a small house, and yet at less cost than where the subdivision is made.

By some little skill in arrangement of bay, ingle, and break, quite enough privacy and separation can generally be secured to fulfil all general requirements, while leaving, for such a climate as Australia, a very fine, spacious apartment, lending itself to good hygiene, as well as to æsthetic treatment.

A plan of this character is shown in fig. 2, Plate V.

This villa faces east, and is approached by a flight of four stone steps to a tiled verandah, where the front door opens into the large common room, the verandah really acting as a sheltering lobby, and the room being separated from direct outside view by a panelled screen harmonizing with the general design of the woodwork of the room.

This common room is 26 ft. long by 18 ft. wide, and has a casement window in its N.E. corner with a long seat under it. There is an octagonal bay occupying the S.E. angle, from which windows look in all directions, the opening being partly screened by an overhead grille. At the southern end there is a large, open fire-place, with small window at one side and door at the other, giving access to the south verandah.

In the front a small room is arranged as a study or supplementary sitting room.

There are four bedrooms, all grouped together and in touch with a connecting lobby, the bathroom being in the midst.

On the S.W. side the domestic offices are all kept together. These consist of kitchen, with a pantry, interposed between the common room and a scullery and maids' room at the back.

The back grouping of the building gives an opportunity for forming a paved court with a high-trellis screening, and with a small fountain in the centre.

This villa is planned for 11 ft. ceilings, one large roof over-spreading the main portion, with running down verandahs, the hipped roofs of the two shallow back ridges running into the main roof.

The common room bay is roofed as a low tower, insetting at the angle of the high roof, with weather vane finial.

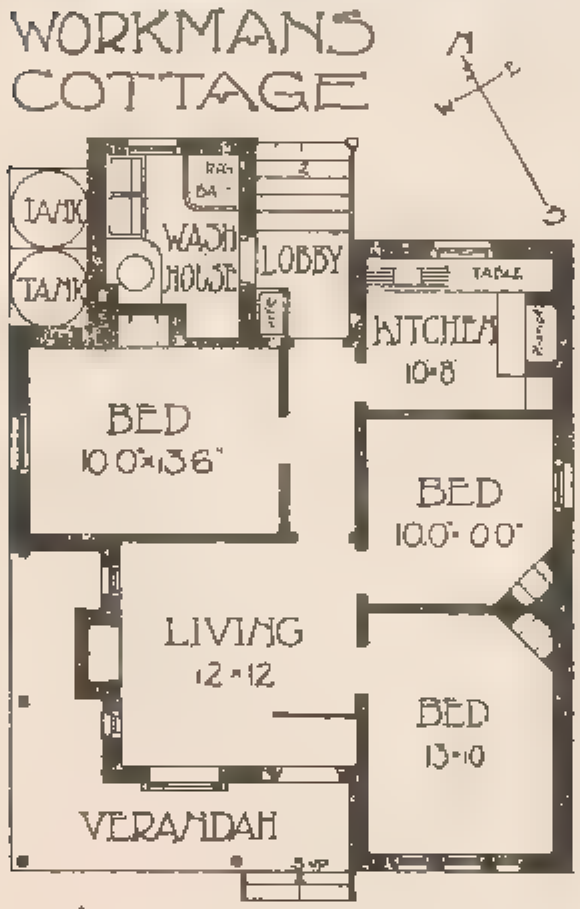
Villas with Attics.—In the southern States, and wherever climatic conditions are reasonably moderate, and allow such a treatment, the roof pitch of the villa may with advantage be increased, and the space so created used as attics.

This attic treatment has many advantages. There is, first of all, the easy creation of extra accommodation at moderate cost; the rooms, too, have a more extended outlook than the ground floor apartments, while the roof, as an architectural feature, is nearly always much improved by increased height and pitch.

As the ceilings of attics are closer to the outside roof surfaces than ordinary apartments, the roof should always be covered with insulating material to, as far as possible, equalize the temperatures, while windows should, where practicable, secure the draught of the cool prevailing winds.

In an attic any of the roof space over about 4 ft. 9 in. in height may with advantage be used, the main height being about 8 ft. On Plate VI. two villa plans are shown, having attic apartments in the roof space.

WORKMANS COTTAGE



OCCASIONAL HOUSE

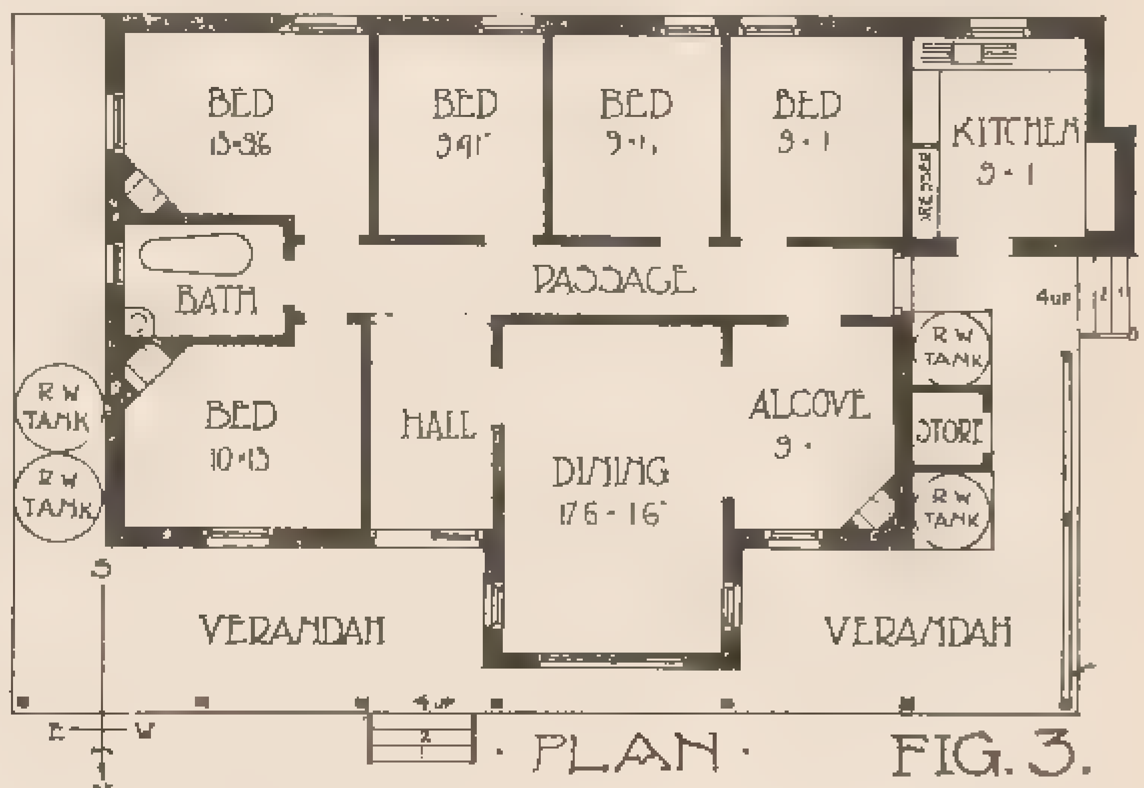
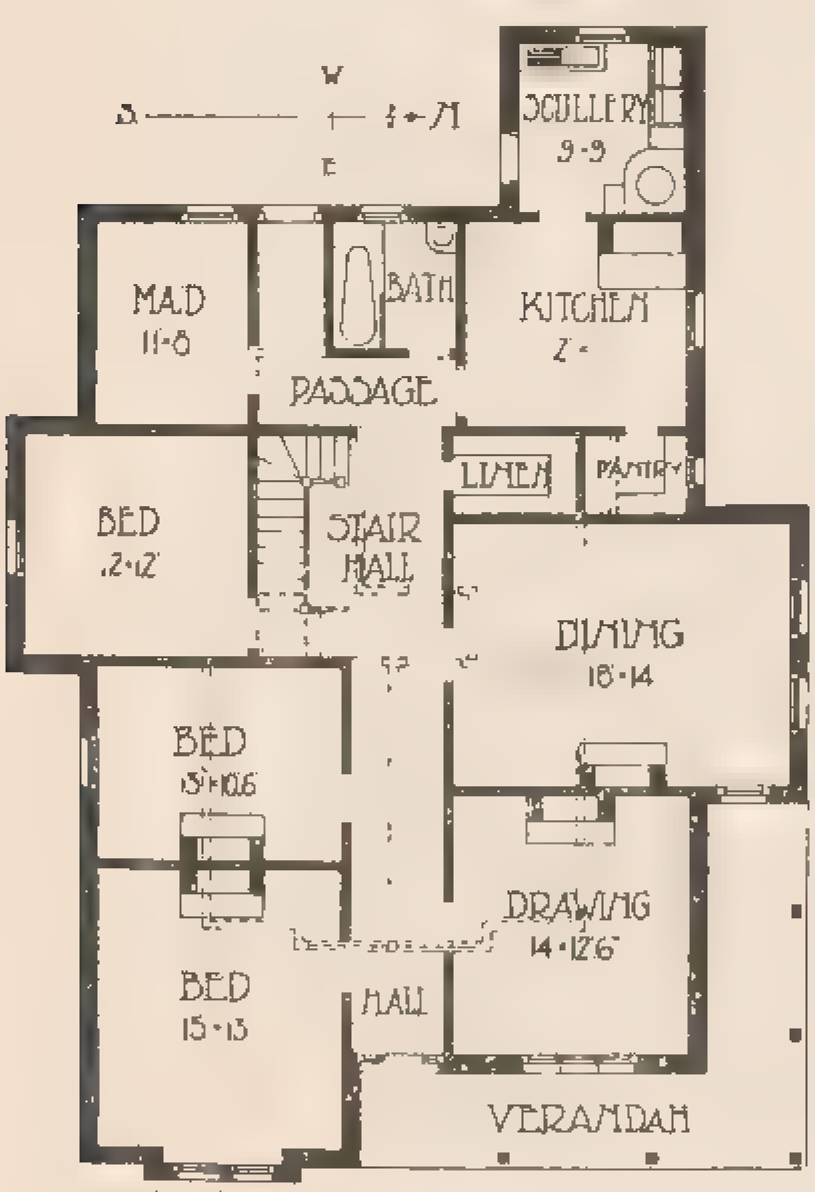


FIG. 4 PLAN · · PLAN · FIG. 3.

TWO VILLAS WITH ATTIC ROOMS



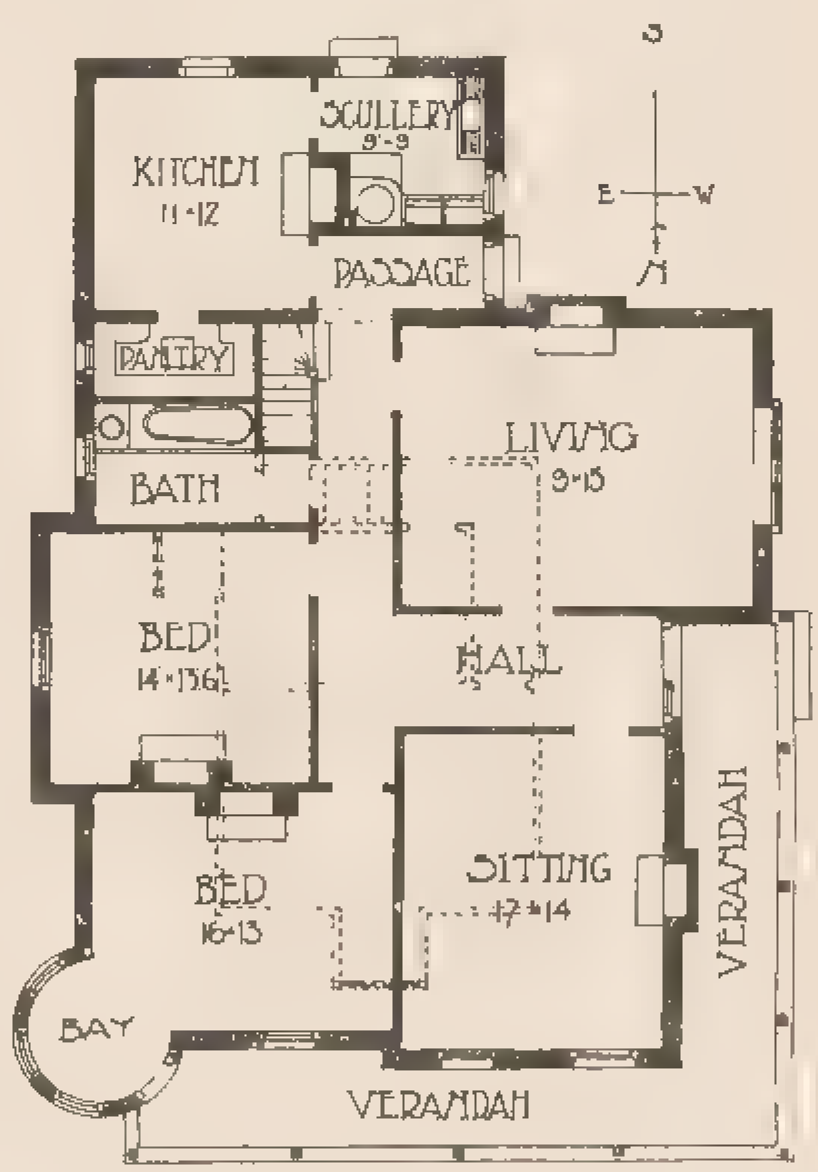


FIG. 1. PLAN · FIG. 2. · PLAN ·

SCALE OF 10 5 0 10 20 30 40 50 FEET.

Fig. 1 may be taken as being reasonably complete as a compact villa plan, even without attics, in which case the stair hall could be made narrower by making the southern bedroom larger and leaving out the staircase.

This villa, with eastern aspect, has direct front door approach and a verandah on the east and north sides, the main apartments being grouped on either side of the straight hall, the living rooms to the north, the bedrooms to the south, and the domestic offices being at the back.

From the stair hall the attics, consisting of three rooms, which are shown by dotted lines on the plan, are reached.

With 10 ft. 6 in. ground floor ceilings, and 8 ft. high attic ceilings, it is roofed high and free over the main mass of the plan, with slopes running down over verandah and scullery, and with gable treatment incutting where the diningroom and two of the bedrooms jut out from the general line.

In the other plan, fig. 2, somewhat less accommodation is shown, there being one bedroom less than in the first plan, and only two attic rooms.

The main approach door is here planned at the side, the fronting aspect of the house being north, with the verandah on north and west.

The living room and sittingroom group are directly right and left off the hall, and the two bedrooms are to the east, the one next the front having a circular bay. The arrangement of the domestic offices here plans well for a small villa, and may be noted.

The small stair to the attic is opposite the living room door, and leads to a box room off the half landing over the bathroom and to two rooms in the roof.

Here, too, the main roof mass is high pitched, and runs down over the verandahs.

Small Country Houses.—Away from the narrow allotment of land, so characteristic of the suburban villa site, the country

villa or bungalow comes as a direct contrast. The planning may therefore with reason be more spreading, and the arrangements made for the exclusion, on the one hand, of many things possible in suburban houses which are not available in the country, and, on the other hand, the inclusion of certain conveniences which are peculiarly necessary in a country home.

The small country house, in our Commonwealth, has a very wide range indeed—from extreme moderation of climatic conditions in the south to tropical conditions in the north. We therefore illustrate a range of various designs, some suited to cool conditions, others to sub-tropical requirements.

Plate VII., fig. 1, shows a plan and perspective sketch of a villa in a temperate part of the country, in which one of the principal objects of the planning has been to counteract the effect of very high prevailing winds from the S. and S.W.

It will be noted that the working parts of the house are compactly planned and well screened from these aspects.

This timber-built house is arranged on a spacious site, and covers a space of some 70 ft. from north to south.

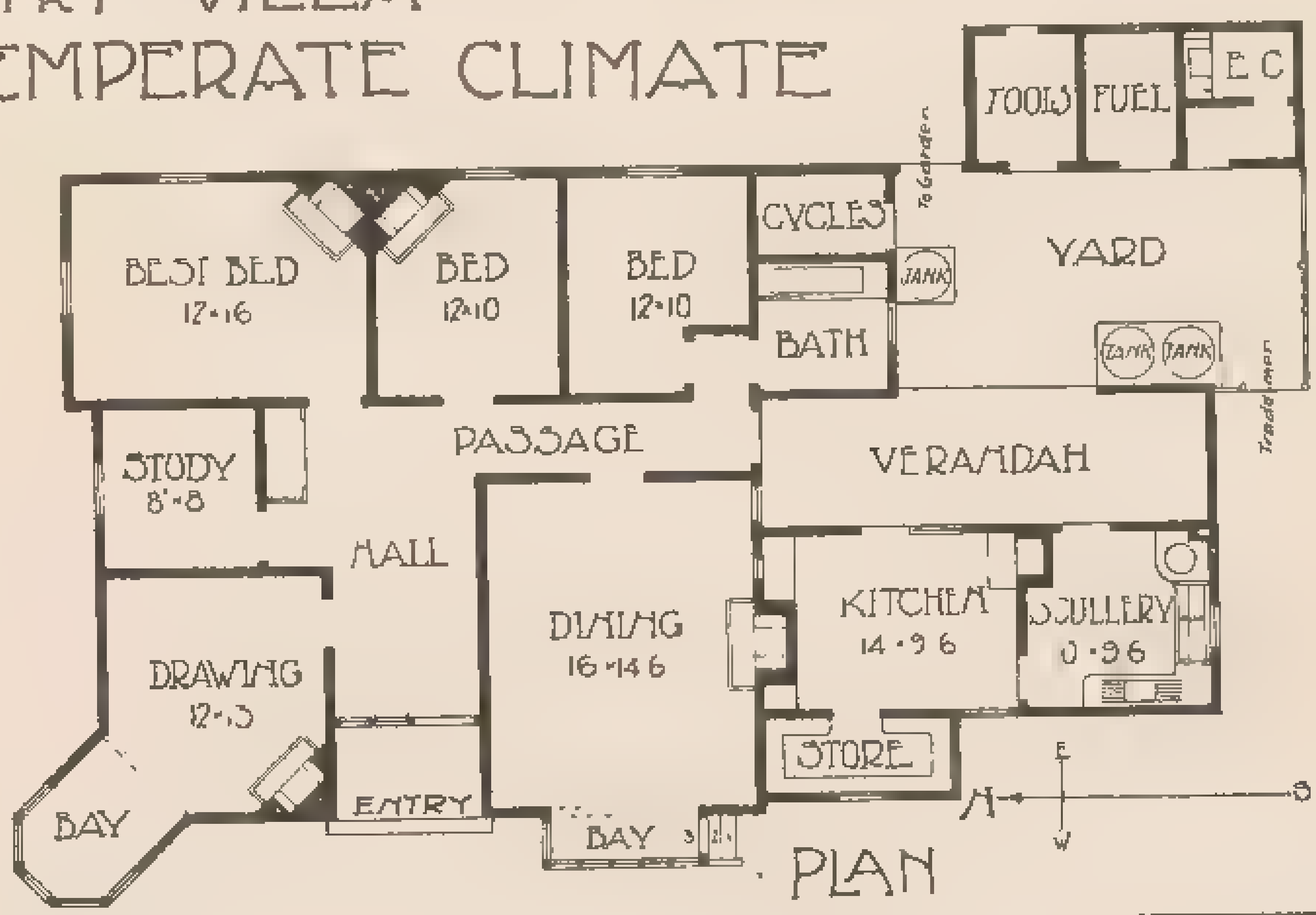
The main entry is sheltered under a small verandah or pent, from under which the hall is entered, the drawingroom to the north having a jutting-out bay at one corner. There is a small study or office off the hall. The diningroom is a long apartment, lighted by square bay windows, from which a small door gives direct passage to the garden. The fire-place is built back into the kitchen, thus leaving the walls flush, with a small servery window and table at the side. The three bedrooms have eastern windows for morning sunlight, and two of them are furnished with open fire-places.

The bathroom is so planned as to allow of the roof running down over to the lower level required.

In this plan the domestic offices are outside the main house, the kitchen being approached by a wide verandah, which is enclosed at the southern end, and has a skylight over, for plant-growing.

Perspective Sketch

COUNTRY VILLA
IN TEMPERATE CLIMATE
FIG. 1



PLAN

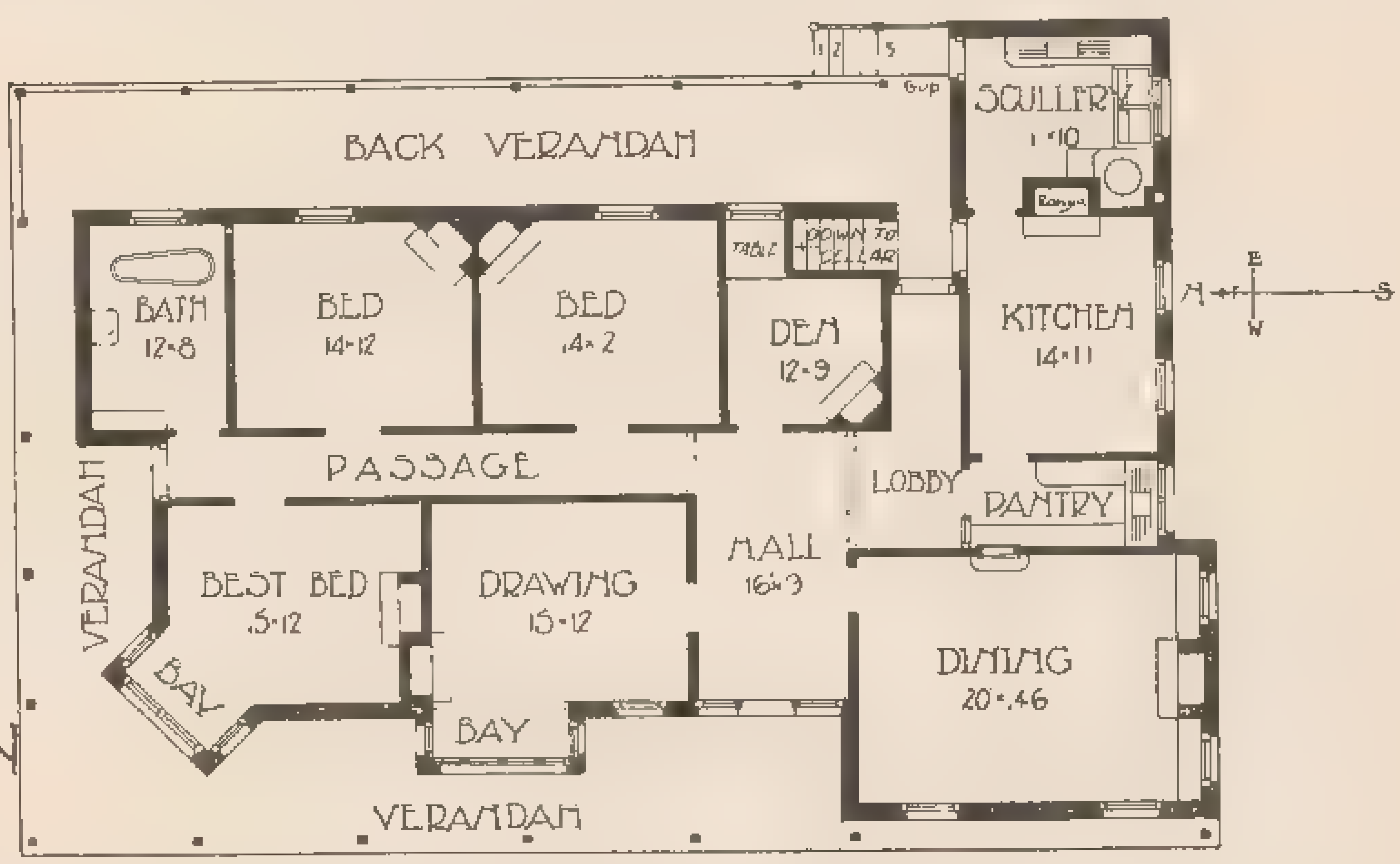


FIG. 2.
PLAN
OF
BRICK VILLA IN HOT CLIMATE.

SCALE OF 10 5 0 10 20 30 40 50 FEET

Off the kitchen is a large store-room, fitted with bins and shelving. The scullery opens off the kitchen, and contains a sink and a draining table. This apartment is also used as a wash-house, and is fitted with a copper and wash-troughs and served by an outside door.

Small detached rooms are arranged outside for tools, fuel, cycles, &c., and in this way a useful, enclosed, paved yard is formed, containing rain-water tanks to supplement the general water supply.

The plan of another country villa is shown on the same plate (fig. 2). This is for a hot climate, and has a verandah on three sides, the south only being left free.

This house supplies the requirements of a small grazier. There is a 9 ft. wide hall, from which drawing and dining rooms open.

The drawingroom is of irregular shape and has a fire-place, arranged in handy proximity to the outlook from the bay window.

The diningroom has southern windows, with bookcases under, upon either side of the fire-place. There are also western windows, to give outlook in this direction, screened by the verandah continuing on as a pent over them. There is a servery hatch through to the pantry, which is fitted with a sink, storage cupboards, and tables, and is arranged towards the cool south.

There are three bedrooms, the best having an angle bay. The bathroom is grouped with them, and is large in size—a feature that is most often required in country houses, where the bathroom, to a great extent, acts as a dressingroom, in which outdoor garments may be changed for indoor clothing after the day's work is done.

A small den, which may be used for office purposes, is planned near the back door, with a window facing the verandah.

Under the den is a cellar approached by a stone stair. This cellar is lighted by a window under the den window, the table acting as a bulkhead in giving height to same.

The kitchen has a cool aspect, and the range has good lighting service. The scullery is also used as a wash-house, and has a door and steps leading direct to the drying ground.

The building is of brick, with 12 ft. ceilings, the whole being covered with a plain, low-pitched, tiled roof, extending without break over the verandahs, and supported thereat with heavy, square posts.

Sub-Tropical Villas.—As a type of a sub-tropical villa, fig. 3 on Plate V. is shown. In this plan the drawing and dining rooms as separate apartments have been dispensed with in favor of a roomy living room, which forms a large, comfortable, and airy apartment for common use. This has an open fire-place by the side of a flat bay window, looking on to the broad verandah.

There is a somewhat steep fall in the land to the front, and the house is kept well up, which calls for approach steps and hand-railing to the verandahs. On the S.E. side this verandah is enclosed, giving space marked "Lounge," for use at meal times during summer, or for sitting out at evening.

Two bedrooms are grouped with a bathroom between them on the north side of the living room, separated by a lobby space, with a wood grille overhead. There are also two other bedrooms at the N.E. corner, from which a vine-covered yard extends westward.

All the internal doors have hung fanlights over them, and, by arrangement of these and opposite windows, cross air currents are set up as much as possible.

It will be noted that the domestic working portion of the house, grouped together on the west, consists of the kitchen and scullery, with a cool inside store and well-sheltered dairy, and a large servants' bedroom, with a passage and way out. The fuel store and E.C's. are kept away in the N.W. boundary of site.

All the rain water is collected from the roofs by a complete system of close-jointed piping, and conveyed to a large underground concrete storage tank in the yard, which has a windmill and pumping gear overhead, from which point a system of supply pipes is conveyed to points where water is required about the house.

The ceilings are 12 ft. high, and the roof is low-pitched and wide-

spreading, and covered with corrugated iron. There is a covering of rough boarding over the rafters, which is laid with non-conducting felt, the roof space being well ventilated to keep apartments as cool as possible during the summer heat.

The structure being of wood, great care has been exercised to prevent the inroads of white ants from the ground, the whole building being set up on stumps of non-attackable wood, covered on top with galvanized iron ant-stops.

Bush Cottages.—A house of moderate size, planned to suit the requirements of a country settler, is shown in Plate VIII.

This house is of timber construction, and has an extra large living room with a southern aspect. There is a small sittingroom off the entry, and it may be noted that the fire-places to these two rooms are of large size and so sunk as not to obtrude upon the room space.

Four bedrooms are arranged along the eastern side. Three of these have eastern windows, while that on N.W. corner has a special balcony, from which a picturesque view is obtained.

The domestic offices consist of a kitchen, with side-lighted cooking stove, sink supplied with water from outside tank, and cupboard store and Scotch dresser. Next the kitchen is a large-sized store-room, fitted with a row of zinc-lined bins, a table under the southern window, and tiers of shelving.

On the other side of the passage is another store, with the bathroom beyond, in which, to save water, a tray bath is fitted with a shower fed from outside tanks.

The windows are mostly casements, of red Californian pine timber, oiled, the glass being in small, clear panes, leaded in.

The outside weatherboards are of jarrah, allowed to go grey. The roof is of corrugated iron, and is well ventilated with louvred ventilators, the ceiling being covered with non-conducting pugging. The inside finishings are entirely in native timbers, plainly treated, and finished with oiled and wax-polished surfaces.

Occasional Houses.—Among small houses an ever-growing number is found among the class of week-end or occasional houses. Our seaside resorts and mountain and country retreats bear witness to the demands of the small house, or cottage, for occasional use.

These are mostly of timber, and require, in several particulars, to be planned differently from the suburban or more permanently occupied property. They range from the one-roomed hut or shanty to the many-roomed villa, and require specially planning and detailing to fit them for their peculiar purpose.

For a house of several apartments the one large common room or dining apartment is best, with small but numerous sleeping apartments, and wide, spacious verandahs, which conserve the beauty of special outlooks, and give opportunity for open-air life.

In matters of detail a few practical points should be noted, as follows:—

The locality should be carefully studied, and prevailing winds noted and allowed for.

Heat rather than cold should be planned out, as the house is for summer use.

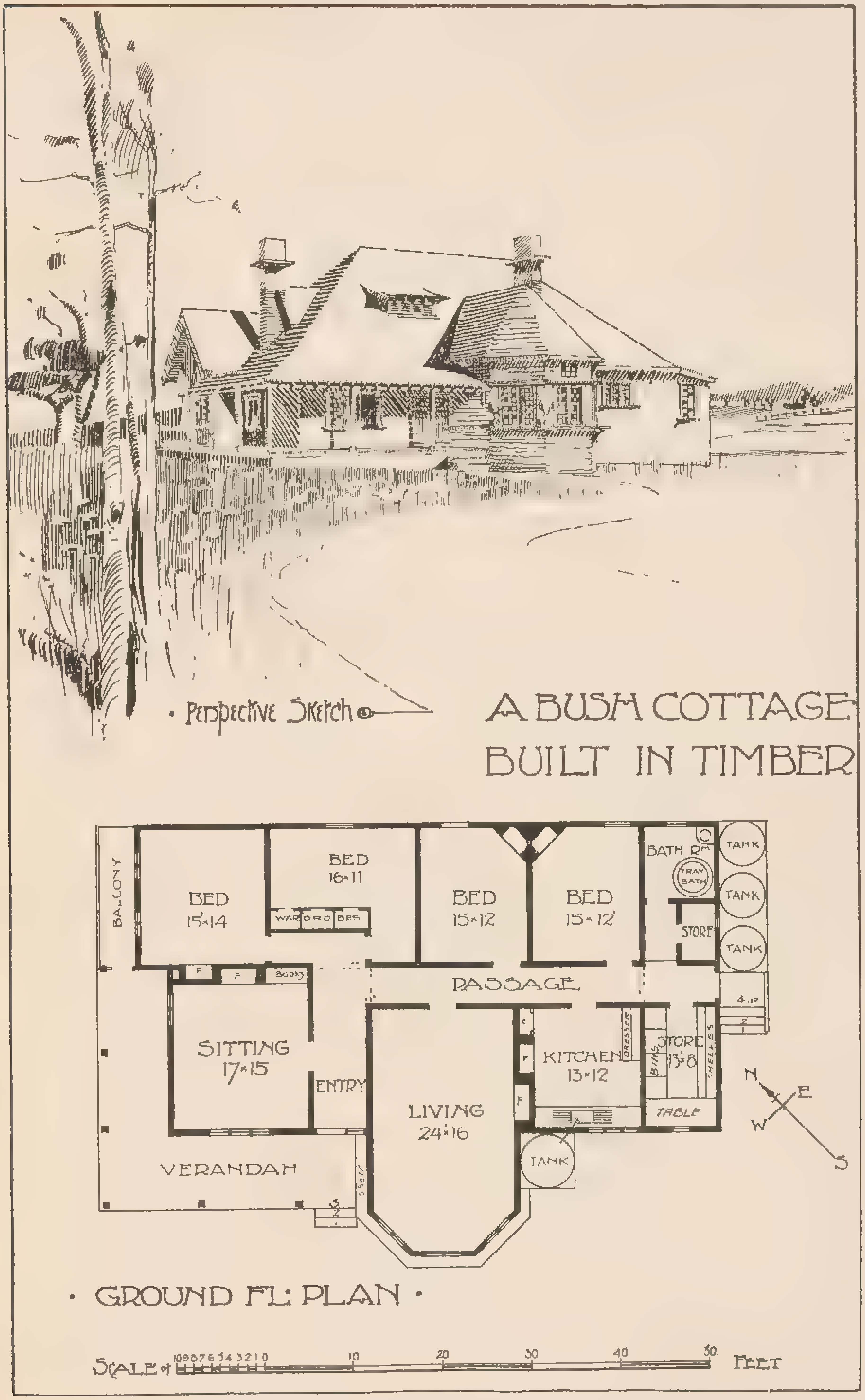
The fierce summer heat of the west must be screened if any comfort is to be secured.

Roof, if of iron, which may be necessary on account of water supply, should be interlined, and, if possible, of double material, to act like the fly of a tent, and thus cool the rooms below.

All windows and outside doors should be fitted with fly-proofing, and windows should be of such a kind that this may be readily done.

There should be ample storage both for cooking utensils, crockery, and for tinned foods. Everything in the stores should be arranged so that if put away and left they may be free from the inroads of mice or ants. For this reason all storage bins, cases, &c., and the store-room itself, should be lined with zinc or galvanized iron.

Water tanks are best planned under the shelter of verandahs, for the sake of coolness. If it is intended to leave the house without a


· Perspective Sketch
A BUSH COTTAGE BUILT IN TIMBER
BALCONY
BED 15×14
BED 16×11
BED 15×12
BED 15×12
BATH Rm
TRAY BATH
TANK
TANK
TANK
STORE
PASSAGE
BOOKS
SITTING 17×15
ENTRY
LIVING 24×16
KITCHEN 13×12
DRESSER
STORE 13×8
BINS
SHELVES
TABLE
TANK
VERANDAH
N
E
W
S
· GROUND FL: PLAN ·
SCALE of FEET

caretaker when not in use, close outside shutters, locked from the inside, should be planned to all windows, and rain water tanks should be enclosed, and arranged with inside taps.

Generosity of fire-place spacing should be a feature, and ample provision should be made for good log fires.

The kitchen, being a hot and odorous apartment, is best kept outside the main building or entirely detached.

Plate VI., fig. 3, shows a design for an occasional house with a northern aspect. There are verandahs on three sides, with the rain-water tanks under shelter. The diningroom has a sitting alcove containing a fire-place, and there are five bedrooms. The bathroom is fitted with water supply from the tanks on the eastern verandah. The kitchen is really outside the main house, and is approached by the verandah, yet is well in touch with the dining-room. The fire-place is built outside the wall, so as not to heat the house, and the window, as do also the windows of four of the bedrooms, faces the cool south. The crockery and utensil storage is in the kitchen itself. The food storage is arranged out-side, between two of the water tanks.

Workmen's Homes.—English architecture has always taken special cognizance of homes for the working classes, and many notable improvements in this class of dwelling have been in-augurated of late years, both in the erection of large, many-storied buildings and also in the building of village houses, to a more healthful as well as a more convenient arrangement of dwelling than was formerly the case.

The system of collective dwellings in large building blocks, where separate tenements are placed together, making one large, many-storied building, has not, thus far, made progress in Aus-tralia. Rather has the tendency been to so cheapen the means of communication as to induce the working classes to seek the more open lands for their dwellings.

If this tendency continue, there should be good oppor-

tunity to bring in an improved class of building, specially suited to families of strictly moderate means.

As this class of property is more often than not letting property, there should be double reason for its general characteristics being convenience, substantiality, and ease of maintenance.

The unfortunate rule that the cheaper the article the more it is ornamented should here be decidedly rejected, as it can be readily shown that for all purposes that which is simple, neat, plain, and honest, if properly designed, will both look best and be best, from a financial as well as a-workable standpoint.

Upon Plate VI., fig. 4, is shown a plan and perspective sketch of a small cottage. There is a front living room and three bedrooms, each with a fire-place. The kitchen is at the back, and is fitted with a compact cooking range, with a store cupboard at the side, and a long table, with a sink and draining board, under the window. A food safe is built on the lobby near by.

Off the back lobby is the wash-house, all under cover, containing wooden wash-troughs in pair, served with soft rain water from the two outside tanks, and with a boiling copper.

A tray bath is also fitted in this apartment, which is sufficient for general purposes where water supply is limited.

This cottage is plainly built of brick, with hollow outside walls, the roof being of Australian tiles, with floors and verandah timbering of jarrah.

CHAPTER V.

LARGE HOUSES.

In the designing of large houses the difficulties that the designer encounters in the small house is proportionately increased, for with the greater number of apartments the opportunities of correctly lighting and grouping them become more complex. On the other hand, the large house provides more scope and opportunity, and many features may be introduced in the larger structure that would be out of place, or impossible, in the smaller building.

The large houses now built are generally detached. The demand for the town house occupying the whole area of a street site is now very limited, as property of this class shows each year an increasing tendency to pass into the hands of professional occupiers, while suburban and out of town houses and mansions grow apace.

The detached house needs the broad setting of an adequate site, and specially so when the greater mass of materials visible outside are new and liable to be garish in color, such as brick walls and tile roofs. These, of course, mellow with time, but if a site be chosen well filled with natural greenery, the result is much happier, both at the beginning and for all time.

All red houses find their answering color note in the refreshing framing of green, and sward and trees alike heighten in no small degree the beauties of the building.

The requirements mentioned in Chapter III. as necessary in good house sites should here be specially remembered, for the success of a building depends in no small degree upon the suitability and value of the site itself.

At the outset of planning, a list of apartments, with the approximate area of each, should be drawn up, and the whole grouped broadly into four sections—namely, reception and living

rooms; sleeping apartments and their accessories; domestic offices, such as kitchen, stores, &c.; and servants' quarters. In addition to these there may be outside buildings, such as stables, men's quarters, and the like.

If all these apartments have to be placed on the one floor, the overspreading area will of necessity be very large, and may lead to long and numerous passages. If a two-story structure be decided upon, some greater compactness of plan may be hoped for, which should not be found inconvenient in working, if easy stairways be made part of the scheme, and with full domestic conveniences so arranged as to make each floor as far as possible self-contained.

Suburban Houses.—A large one-story suburban house is delineated upon Plate IX.

This plate shows the ground floor plan, having an elongated western front of some 145 ft., with 26 apartments and offices.

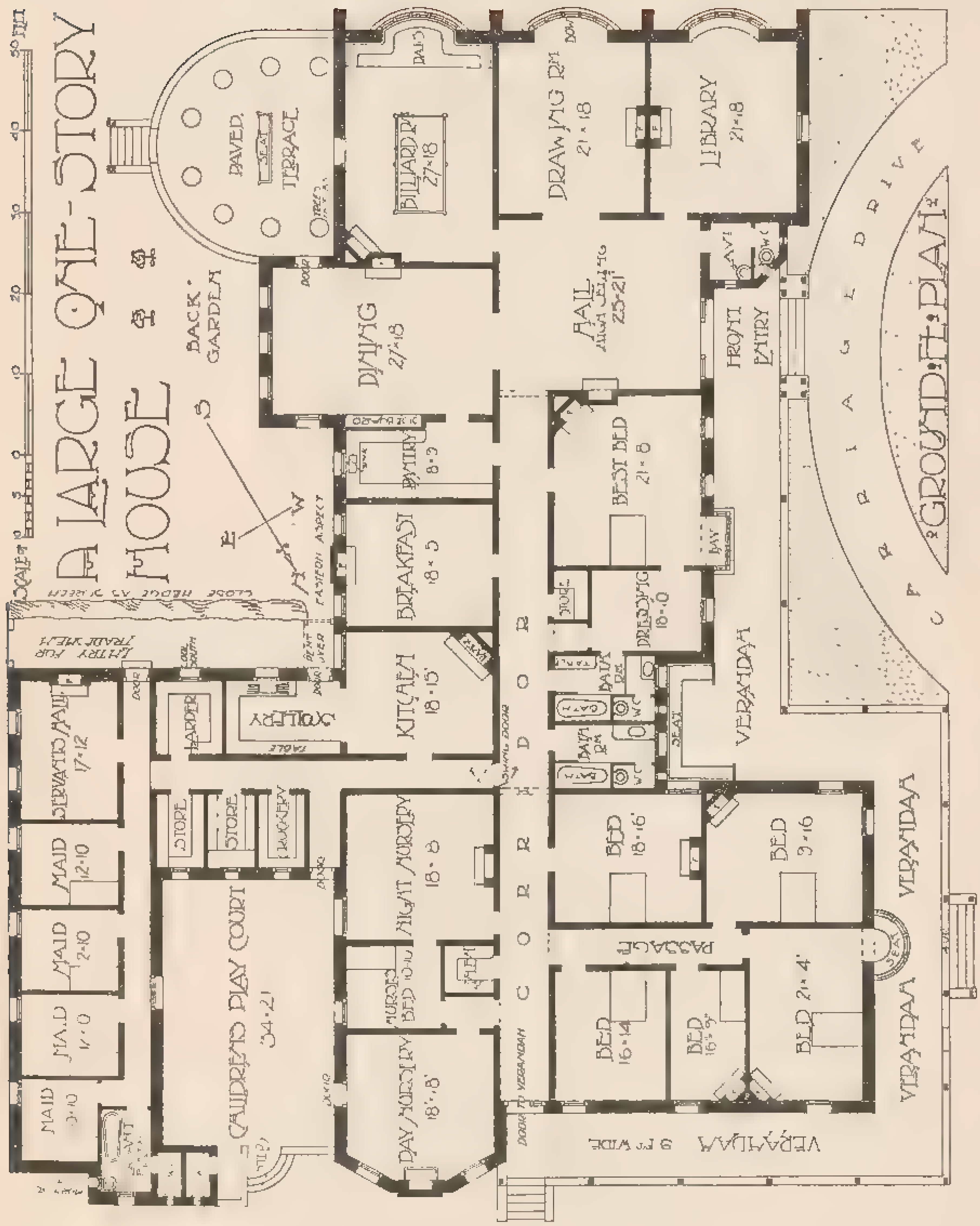
The reception apartments are grouped together at the southern end, and consist of a large entrance hall, off which four other rooms open—viz., dining, billiard, drawing rooms, and library. Near the entry, at the corner of the hall, is a small lavatory and cloakroom with 8 ft. high ceiling. In the billiard-room provision is made for artificial lighting, while here, as also for the drawing-room and library, the southern aspect gives opportunity for large bow windows with broad glass display.

Doors from the dining and billiard rooms lead to a paved terrace with seats and trees in tubs, surrounded by low parapet walls, and with a flight of steps down to the back garden.

Next the diningroom is a roomy pantry. This also serves the breakfastroom, which is specially arranged with eastern aspect.

The general bedrooms are grouped along the west and north, and are of various sizes, all opening on to a 9 ft. wide verandah, and having generous bath and lavatory accommodation. The best bedroom has an attached dressingroom and private bathroom.

PLATE IX.


A LARGE ONE-STORY HOUSE
GROUND-FL-PLAN
CARRIAGE DRIVE
BACK GARDEN
PAVED TERRACE
BILLIARD RM 27·18
DRAWING RM 21·18
LIBRARY 21·18
DINING 27·18
HALL 25·21
FRONT ENTRY
BEST BED 21·8
PANTRY 8·9
BREAKFAST 18·5
KITCHEN 18·15
SCULLERY
LARDER
STORE
STORE
LAUNDRY
SERVANTS HALL 17·12
MAID 12·10
MAID 12·10
MAID 11·0
MAID
CHILDRENS PLAY COURT 34·21
NIGHT NURSERY 18·8
DAY NURSERY 18·8
CORRIDOR
BED 18·16
BED 9·16
BED 16·14
BED
BED 21·4
PASSAGE
DRESSING 18·0
BATH RM
BATH RM
VERANDAH
VERANDAH 9 FT WIDE
ENTRY FOR TRADESMEN
CLOSE HEDGE AS SCREEN
SCALE
50 FT


A LARGE
ONE-STORY HOUSE
for Plans see Plate 9.

The small bedroom on the northern front could also be used as a dressingroom, *en suite* with one of the larger bedrooms.

Provision for children is made in large night nursery and nurse's bedroom, with day nursery having sunny eastern and northern aspect, with play court attached.

The domestic offices consist of kitchen, cut off by a swing door from the rest of the house, scullery off the kitchen, four stores, tradesmen's entry, &c.

The servants have their own hall, and four bedrooms, with eastern aspects, are provided for maids. The servants also have their own bath and W.C.

This plan, while securing correct aspect for the various apartments, lends itself to simple roofing and massing.

One main span of roof, from west wall of bath to east wall of kitchen, covers the long central portion, into which the other portions of roof naturally converge.

A generous length of verandah, portion of which is covered with sloping slate roof, and the remainder with metal flat, runs around northern and western fronts. At the entry the verandah is extended to form a pent, to protect carriage ingoing in wet weather. This pent is suspended over the drive on wood brackets, framed beam-wise over posts.

The general external walling is of rubble stone, with dressed white stone sills and dressings, the main surfaces being finished in white roughcast.

The roofs are covered with purple slates. The verandah floors are of 6 in. by $1\frac{1}{2}$ in. red tiles laid herring-bone wise, and all external woodwork is left natural and well oiled.

The general ceiling height is 12 ft. for main building, and 11 ft. for maids' rooms, scullery, and stores.

A perspective drawing of this house, as viewed from the south-west, is delineated upon Plate X.

Plates XI., XII., and XIII. show plans and perspective of a large two-story suburban house.

This house shows an extended frontage to the S.E., and is flanked with a wide verandah, extending at the end into a broad loggia, which offers ample space for sitting out.

The main entrance is up a flight of steps to the tower porch, which leads to a vestibule. This vestibule is screened from the hall by a carved ornamental wooden screen, which extends across and continues in front of the staircase.

The hall is 30 ft. wide, with direct light to the verandah, and offers a central communicating apartment to the house, with large fire-place and wainscotted blackwood treatment.

The staircase commences just off the hall with three steps, starting on to a square landing, which gives good effect. Under the stair a small lavatory and cloak-room is arranged, with a door to the outside from the back verandah.

The drawingroom, to the south of the vestibule, is a rectangular room 22 ft. by 18 ft., with two bays with casement windows and window seats. From the southern bay a door leads direct on to the loggia.

A day-room is planned at the end of the vestibule, and a smoking-room, having a three-quarter round bow window, with a seat and table looking to the north and west.

The diningroom is a large one, being 27 ft. by 17 ft., with bay end jutting beyond the general front line of the block. The serving is done from the kitchen, across the servants' passage to the servery, which is near the back stair. This servery is fitted with cabinets, table, and a rotating serving drum.

A servants' hall, 17 ft. by 16 ft., is arranged next the kitchen, with windows looking on to the kitchen yard, and a fire-place between, so planned that fire and outlook may be enjoyed together.

The kitchen has a left-hand light to the range, and a door direct to verandah for tradesmen.

The scullery is off the kitchen, the sink being directly under good light.

Stores are arranged partly in a cool basement served by the back stair. There is a crockery store off the servery, and a larder and pantry side by side off the servants' passage. These, by their window arrangement, catch the cool south wind.

At the northern end of the plan a range of domestic offices is thrown out in such a way as to screen the house from the hot and dusty north winds. These offices consist of a wash-house, 15 ft. by 12 ft., fitted with four wash-troughs and copper, the door being off the verandah; a laundry, 12 ft. by 12 ft., within the house, coal and wood stores, and three E.C's.

The kitchen yard is enclosed by a brick wall, and is paved and surface drained. This area is arranged for general outside domestic use.

The larger portion of the plan upbuilds into a two-story treatment, the northern block from the scullery being roofed over as ground floor offices only.

The back stairs lead up to two servants' bedrooms—one large and one small—and maids' bathroom and general linen store. These are all cut off from the main bedrooms by a half-glass screen and door.

The main first floor apartments consist of six bedrooms of varying size, all served with balconies.

The large bedroom, No. 1, has a dressing room attached, with a private bathroom. The general bathroom is central, and near the head of the staircase, the bedrooms being on either hand.

The balconies are specially arranged so that the cool southern winds of summer may be enjoyed by easy access from all apartments.

The perspective drawing, Plate XIII., shows the general elevational treatment.

The walls are carried up for the most part in plain brickwork, the sills and window-heads and copings being of freestone.

The verandah floor, being high up from the ground, has a dwarf

wall treatment upon which the whole of the wooden superstructure is built.

The posts are of 7 in. by 7 in. turned wood, supporting a half-timber and roughcast and wood pierced curtain screen, which comes down below the balcony floor to offer additional shelter on the verandah.

Where the verandah, at its southern end, extends into the wide loggia, it is partially roofed over at the verandah top level with tiles, the general portion being carried round the house as an ordinary balcony.

The balcony is roofed by the carrying down of the wide-spreading roof of the house, the south end being finished with a bold half-timber gable.

The balustrading is partly of pierced work, relieved with close-set shingling, the ceiling being of lined open timber work.

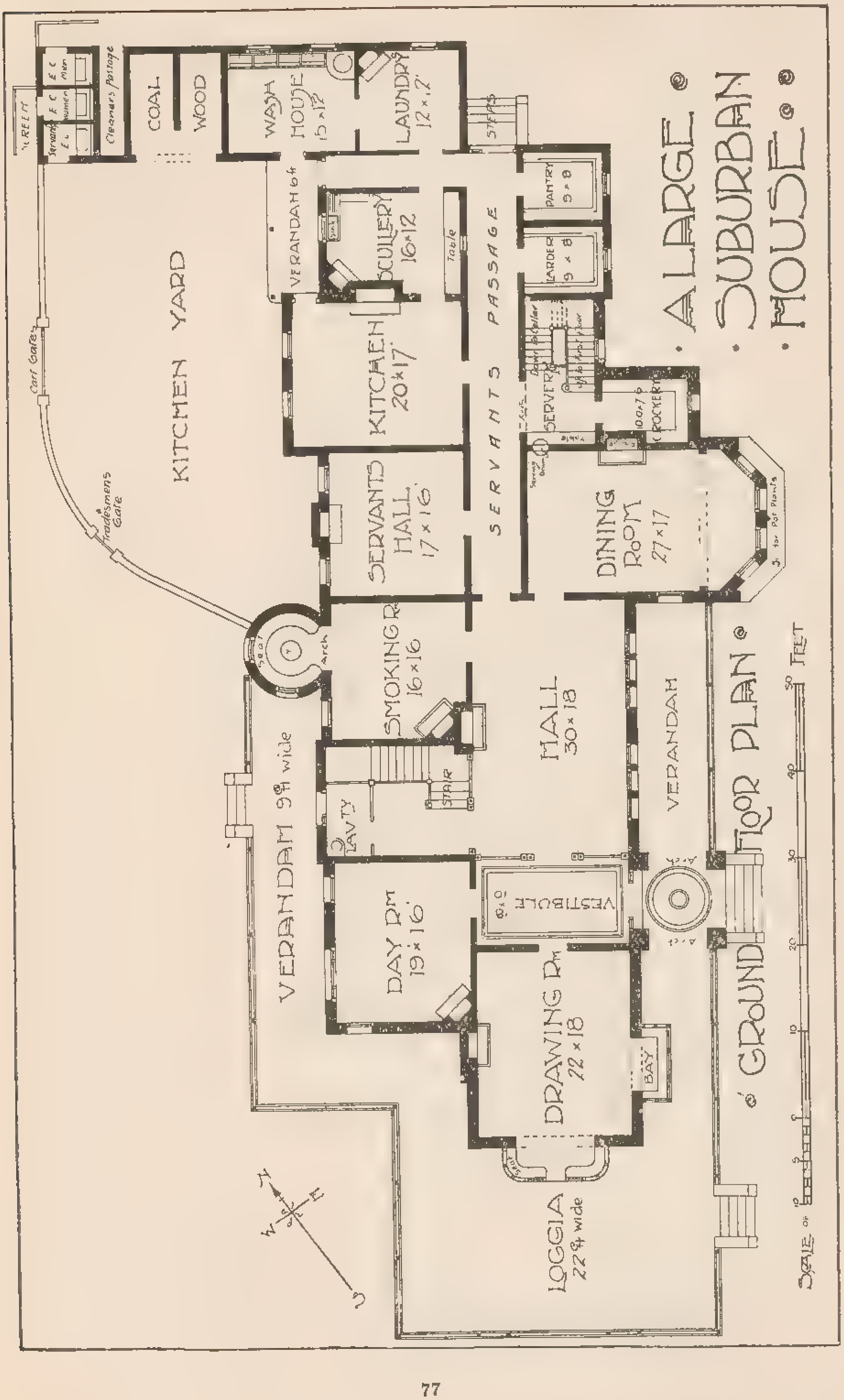
The tiled roof is gable-ended at out-jutting of projections, and some break of line is obtained by roofing over the end of the diningroom as a flat, and carrying up only a portion of the mass to the full height, to form bedroom No. 6. This arrangement provides a private balcony for the room.

A tower rises over the main entrance, from a square to an octagonal form, gradually finishing in the round, with copper dome and wrought-iron finial.

Country Houses.—The large country house may well be considered as in many ways distinct from the town or suburban house.

The country house is, most often, away from the direct supply advantages of towns, and, in the extended areas of the country, the house of the squatter or large estate owner needs specially to be very self-contained, particularly with regard to many things that make for difference in planning.

There is generally, first of all, but small consideration required for limitation of site. Given many acres of land on station, farm,


A LARGE SUBURBAN HOUSE
GROUND FLOOR PLAN
KITCHEN YARD
Cleaners Passage
COAL
WOOD
WASH HOUSE
LAUNDRY
STEPS
VERANDAH
SCULLERY 16×12
Table
SERVANTS PASSAGE
PANTRY 9×8
LARDER 9×8
KITCHEN 20×17
SERVERY
CROCKERY
SERVANTS HALL 17×16
DINING ROOM 27×17
SMOKING R 16×16
HALL 30×18
VERANDAH
STAIR
LAV'TY
VESTIBULE
DAY RM 19×16
DRAWING RM 22×18
BAY
LOGGIA 22ft wide
VERANDAH 9ft wide
Cart Gate
Tradesmens Gate
Arch
Seat
SCALE OF FEET
N
E
W
S

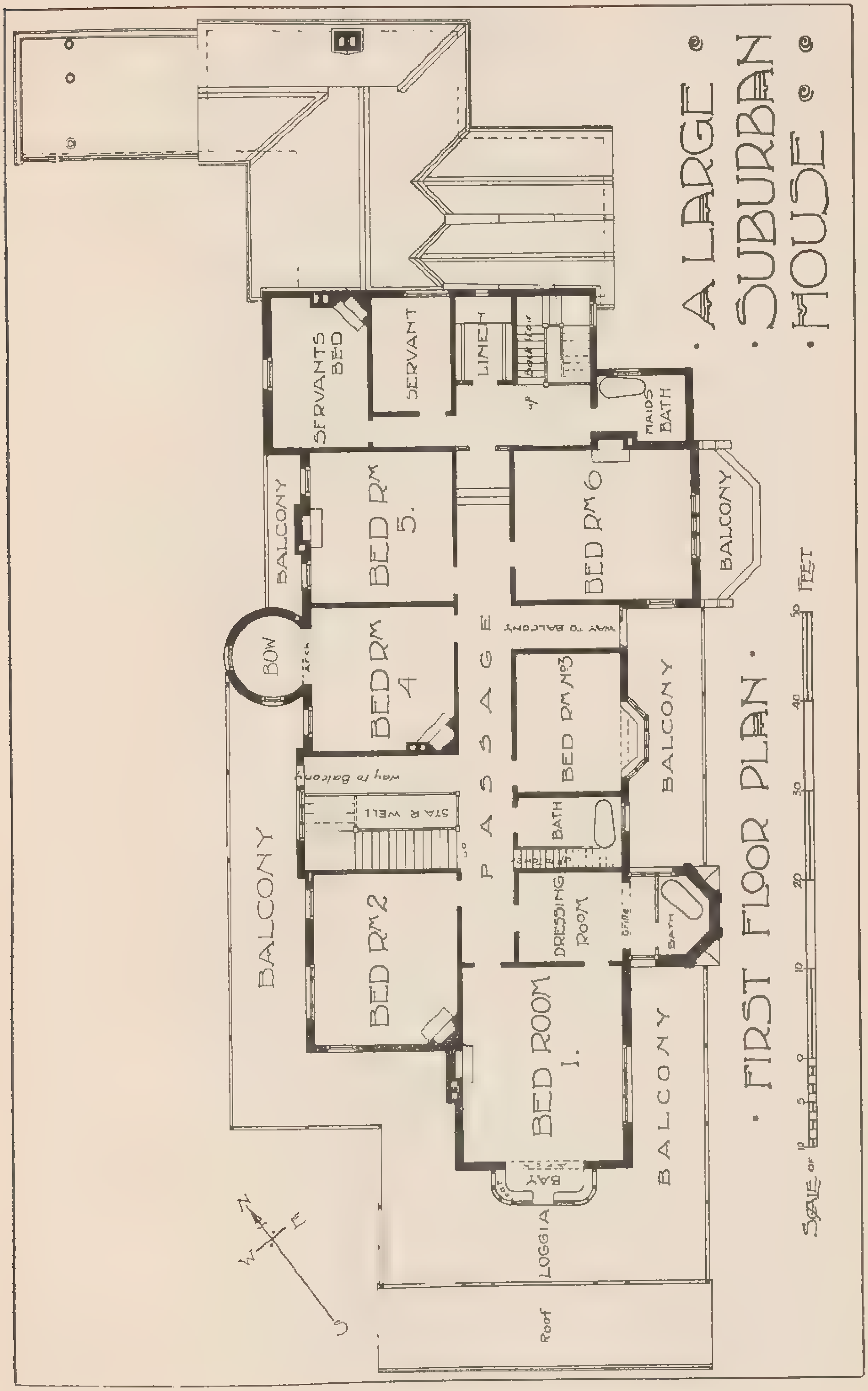
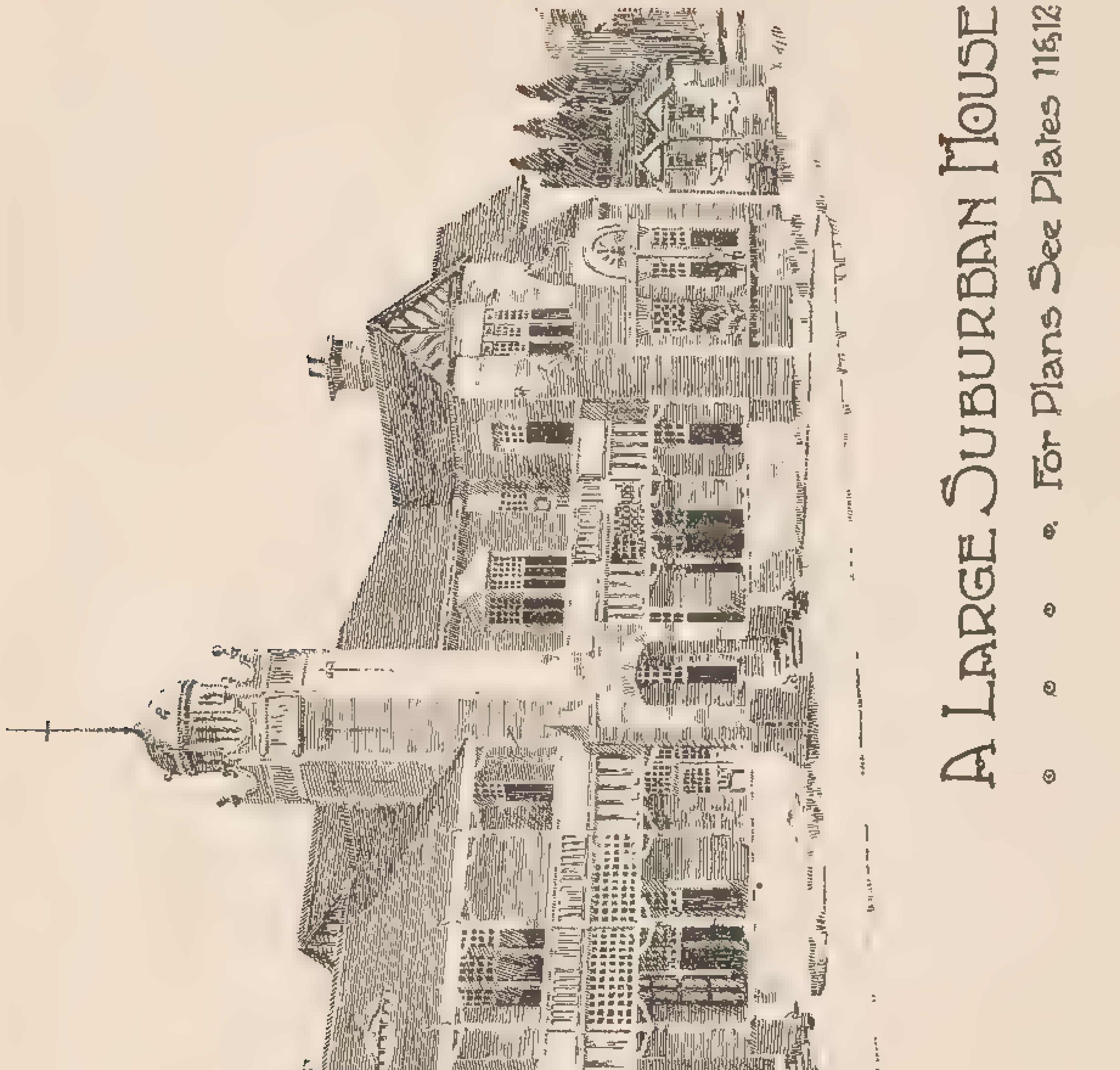

A LARGE SUBURBAN HOUSE
FIRST FLOOR PLAN
SERVANTS BED
SERVANT
LINEN
MAIDS BATH
BED RM 5.
BED RM 6
BALCONY
BALCONY
BOW
BED RM 4
WAY TO BALCONY
PASSAGE
BED RM No3
BALCONY
way to Balcony
STAIR WELL
BATH
BALCONY
BED RM 2
DRESSING ROOM
BATH
BED ROOM 1.
BALCONY
BAY
LOGGIA
Roof
SCALE OF FEET
N
S
E
W

PLATE XIII.



A LARGE SUBURBAN HOUSE

For Plans See Plates 11 & 12

7

run, or estate, a suitable spot for the house is generally chosen, embodying, if a wise choice be made, consideration of level of land, dryness, accessibility to roads, aspect, outlook, and suitability for drainage.

To decide upon the most suitable building materials, also, is often a matter of considerable moment and expense. The special expedient of opening up new quarries, or the local manufacture of bricks, and the important question of carting timbers and finishing goods over considerable distances, must be allowed for when the design is being prepared. These contingencies will often considerably restrain the elaborateness of the country house, and lead to its character being the more utilitarian than ornamental.

The number and general size of the apartments must be first of all approximated, and usually these will be found to differ from town houses.

The one-story house undoubtedly finds the most favor for country houses, even though, by reason of the accommodation required, they have to extend over wide areas, in which passages have to be multiplied.

There is, however, a strong feeling among many, that a one-story building is easier to administer, and where this is the case the building is better so planned.

For a building of this character a massing of main apartments along a rectangular front, with entrance in the centre, having one back wing for kitchen offices and servants' quarters at one end, and a corresponding wing for bedrooms at the other end, thus forming a back central courtyard, is a method often adopted.

With well-planned sanitary conveniences there seems no reason why a two-story house should not be found as convenient, or even more so, than a one-story house, for in this way all the sleeping apartments may be self-contained upon the first floor, leaving the ground floor free for living and reception rooms and administrative offices.

An office, in some convenient place at the back or side of the house, with access from inside, yet with outside door, where men may approach, is often required in the country house. A lavatory and coat or gun room in a similar position are also often desirable where persons coming in from outside occupations or sport may wash and partially change garments and boots before entering the house proper.

Servants' quarters should be very spacious in country houses, where servants have to live away from the amusements of town, and as much accommodation should be provided for their convenience as possible. Each servant should have a separate bedroom; there should also be a servants' bath and common sittingroom or servants' hall and distinct sanitary offices.

Men's rooms are best planned away from the house in detached buildings.

In laying down the orientation of the plan and the aspect of the apartments, the general rules laid down in the chapter upon "Planning and Design" should here be carefully applied, side by side with considerations of local climate and conditions.

The hall, of generous dimensions, may well enter into the design of the country house, and, if of two stories, good effect may be obtained by carrying up this apartment the full height of the building, and grouping the rooms around.

The extent to which the verandah is made use of in the planning will depend very largely upon the heat or temperature of the climate, but in all country houses, even in temperate zones, the verandah adds much comfort to the house, if so arranged as not to obscure needed sunlight from the apartments, and if portions be arranged with Venetian shutters or glass sheltering screens much added convenience may often be obtained.

The man in the city, where constant water supply is the daily order of things, will find it difficult to realize the vital importance of this matter to the country house. The old settlers often built

near by to creeks or watercourses, but, whether this be done and the supply obtained by pumping or well-sinking, or whether the rainfall alone be depended upon, this question of water must have important place in the planning.

For reasons of rain water supply the roof covering is best of galvanized corrugated iron, as, even with a light fall of rain, there is no loss by absorption, a loss which is considerable where tiled roofs are put on.

From an æsthetic standpoint, the tiled or the slated roof is, of course, undoubtedly best, and where the whole of the water supply is not obtained from the roof, this form of roof-covering could be adopted.

Underground or semi-underground tanks are generally the best to a large house, with all eaves spoutings made large and kept clear of *débris*, the down pipe heads being screened with wire to prevent leaf choking, and all underground pipe runs to the tank being hermetically jointed in cement, and laid so as to minimize the danger of fracture from settlements or tree roots, and consequent possible contamination.

The best kind of tank is one made of reinforced concrete, capable of being flushed out, above which automatic windmill pumping gear is fitted, with small storage tanks, and a complete system of galvanized iron, welded tube supply pipes carried to all points in the house as to a town residence.

Next to considerations of local climate, and side by side with it, is to plan against the insect pests—the mosquito, the ant, and the fly—and this planning will add materially to the success of the country house.

A complete system of window and door fly wire-proofing may often with advantage be adopted. Perhaps a removal system is best, where frames may be taken down in winter, numbered, and stored till again required for summer use.

For this reason the double-hung window, with its box frames, though not so pleasing in design as the casement, is often more

practical, as this type of window leaves openings free both for outside and inside blinds.

Where termites are prevalent, it will be understood how important it is that all timber should be specially guarded from their ravages, and a complete barrier system against their inroads built up between the ground and the house.

The country house, in a special degree, requires liberal storage room. Where large quantities of food supplies have to be kept, zinc-lined bins and well-shelved and cupboard-fitted store rooms, and pantries with impervious floors, need to be planned.

Food larders should always be upon the cool side of the house, and as far as possible, subject to cool air currents.

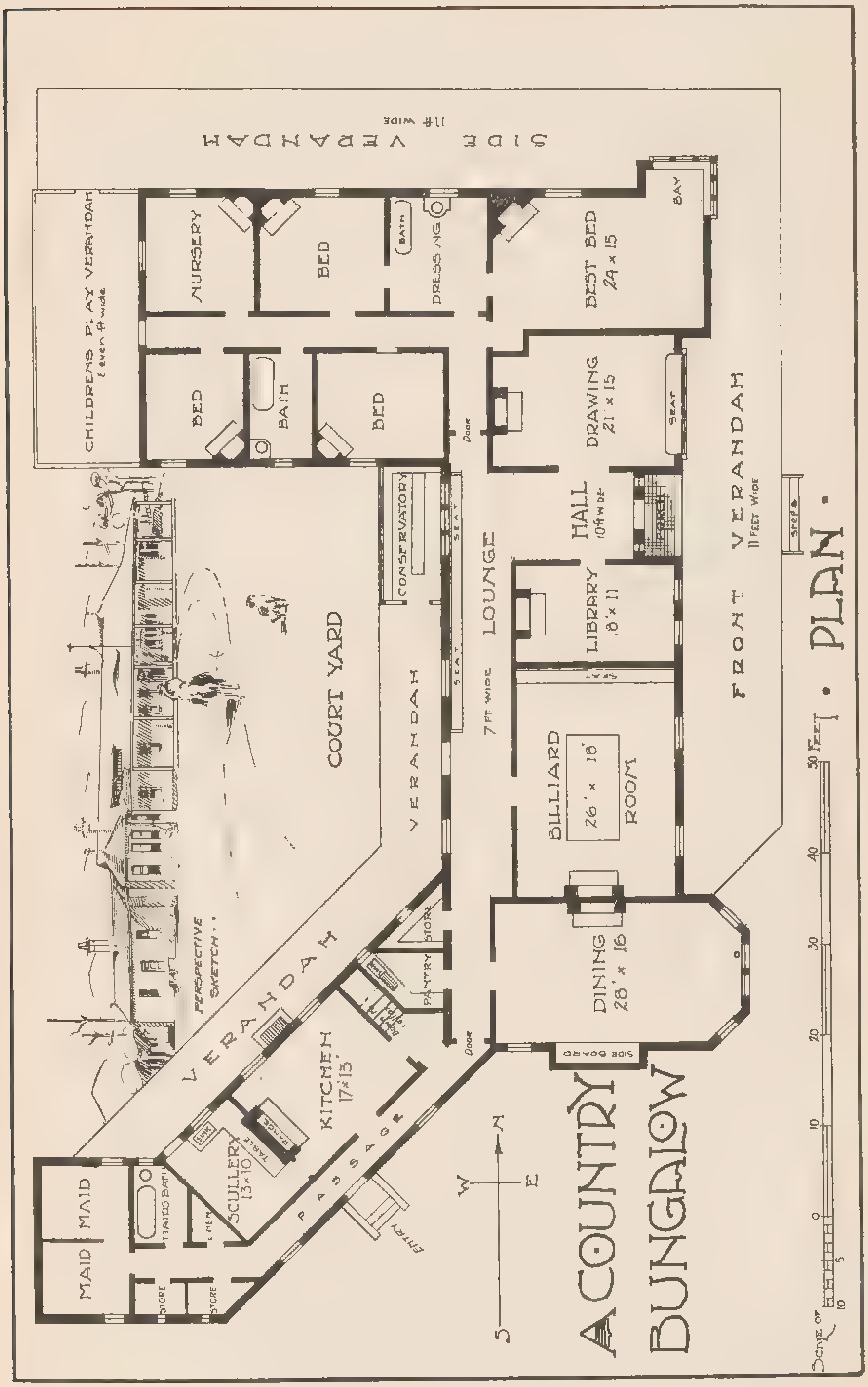
Dairies should have well sheltered and hollow walls, and, if directly under the roof, the covering should be specially insulated, with eaves widely overhanging to create shade. The floor, wall surfaces, and all fittings should be impervious, and so arranged that they may be flushed with water throughout.

If the water supply be in any way sufficient, the country house offers good opportunity for the installation of a small, self-contained system of septic tank drainage disposal, all the fittings of the house being arranged and trapped as for a city system, with underground main pipe run to a small, air-tight septic tank, through which the flow may pass to a coke filter bed, and thence as effluent to trenched and planted garden or fodder land.

If power is available, and skilled mechanical aid to hand, an electric light plant will be found suitable for lighting a country house. Acetylene gas also offers a clean and effective system, being easily self-contained, and, if a generator which drops the carbide automatically in a limited quantity into the water be used, but little attention is required. The pipes may be ordinary gas pipes, save with very carefully tightened joints, and the burners of special pattern.

If kerosene lamps are used, there should be a proper lamp-room allowed for in the planning, where everything connected with lamp filling and cleaning may be kept.

PLATE XIV.


SIDE VERANDAH
11 ft WIDE
CHILDRENS PLAY VERANDAH
Eleven ft wide
NURSERY
BED
BATH
DRESSING
BEST BED
24 x 15
BAY
BED
BATH
BED
DOOR
DRAWING
21 x 15
SEAT
HALL
10 ft WIDE
FORCH
STEPS
CONSERVATORY
SEAT
LOUNGE
7 FT WIDE
LIBRARY
18 x 11
SEAT
FRONT VERANDAH
11 FEET WIDE
COURT YARD
VERANDAH
BILLIARD
26' x 18'
ROOM
PERSPECTIVE SKETCH
VERANDAH
STORE
PANTRY
DOOR
DINING
28' x 16
SIDE BOARD
KITCHEN
17 x 13
RANGE
TABLE
SINK
SCULLERY
13 x 10
PASSAGE
ENTRY
MAID
MAID
MAIDS BATH
STORE
STORE
N
S
E
W
A COUNTRY BUNGALOW
PLAN
SCALE OF FEET
10 5 0 10 20 30 40 50

The country house, of all houses, should have the quality of simple and direct purpose in its constructive character.

Where the aspect is open and wide, large, plain masses, if well proportioned, are all that are required in the outside design, and the plainer the general detail is made the better.

Internal roof guttering, complicated systems of drainage, lighting, or equipment, excess of outside woodwork requiring painting, or anything likely to require sudden or special attention, should be avoided, remembering the position of the house away from the general service of skilled workmen.

The successful planning of the country house, more than any other, is dependent upon the arranging of a large number of accessory buildings and enclosures. The garden, the approach, the horse paddocks, the men's quarters, the stables, workshop, laundry, and many other small buildings have to be allowed for around the house, and in the progress of modern invention these show their evolution, and change with the coming of such things as motor cars, acetylene gas plants, and bacterial systems of sewerage, which modern requirements should have due consideration in the design of the country house.

A Country Bungalow.—A country bungalow design is shown upon Plate XIV.

The plan shows a house of considerable dimensions planned for a position where unlimited area of land is obtainable.

The climate being hot, endeavour has been made to so open out the plan as to induce cross currents of air from the prevailing winds.

It will be noticed that in broad massing the plan is roughly divided into three parts the central living part, the north sleeping part, and the south domestic part.

The general aspect is east, and entrance is across an 11 ft. wide verandah to a porch, which leads into a 10 ft. wide hall some 21 ft. long, lighted at the western end by a long set of windows looking into a conservatory.

Opening off the hall is the drawingroom, with double doors, and long, low, casement windows with window seat.

The library, an apartment 18 ft. by 11 ft., is upon the opposite side. Through the hall running along the western side is a wide corridor, used as a lounge, and fitted with seats. From this a door opens to the back verandah and courtyard.

A 26 ft. by 13 ft. billiard-room is planned next the library, and beyond the billiardroom, at the cool southern end, the diningroom is placed. This room is 28 ft. long by 16 ft. wide, the eastern wall being arranged with bay end. There is a wide outside recess in the southern wall for the sideboard, which, by this means, is prevented from obstructing the general width of the room.

The diningroom is in easy touch with the kitchen and domestic offices, which are arranged at an angle of 45°, so that wind may pass right through and across the apartments, and, while cooling the rooms, prevent any cooking odours from entering the house proper.

The domestic offices consist of a 17 ft. by 13 ft. kitchen, with side-lighted range, and a scullery off the same, with ample table and sink accommodation and a door leading out to the verandah.

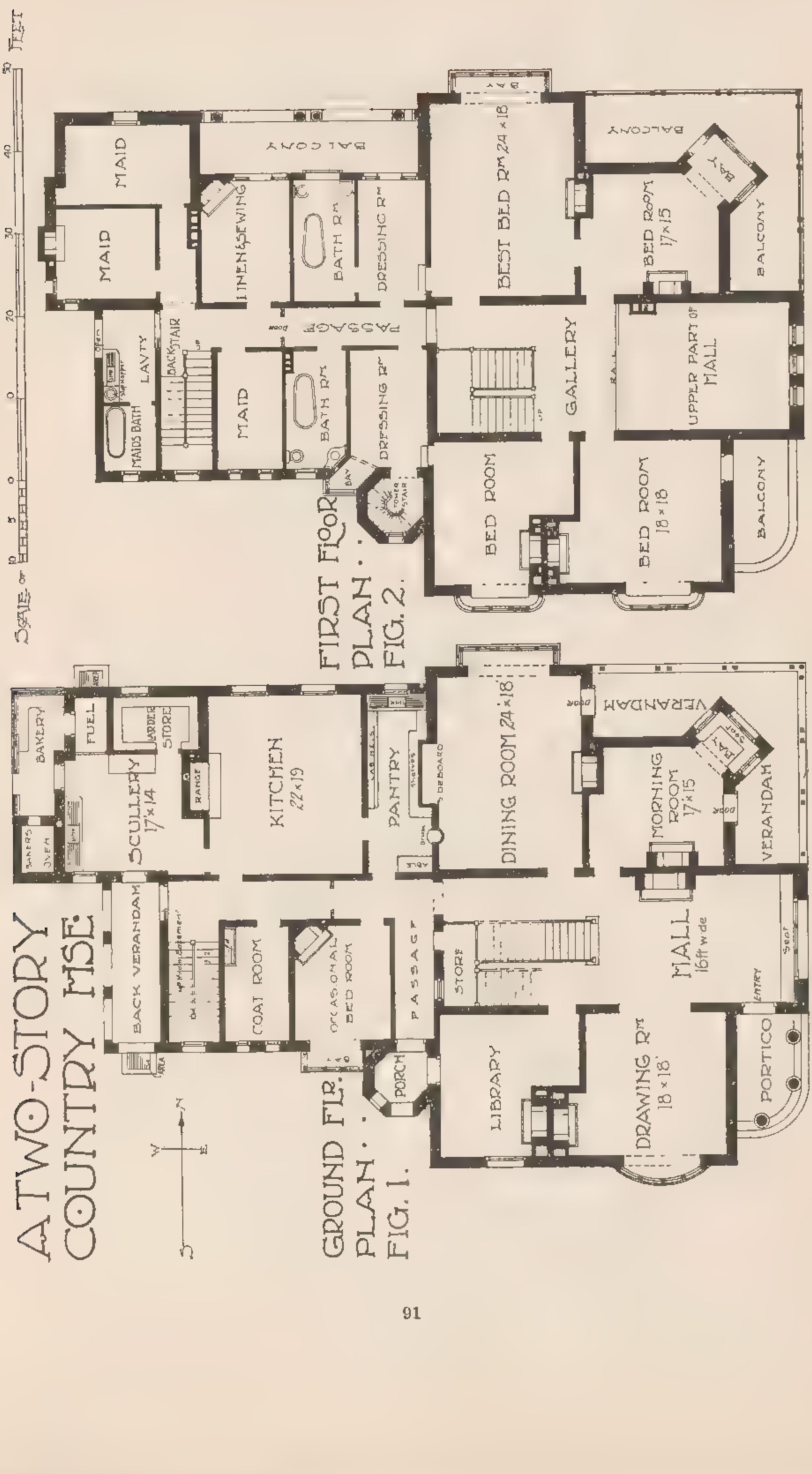
There is a pantry with sink and cabinets opposite the dining-room door, also a store for general purposes.

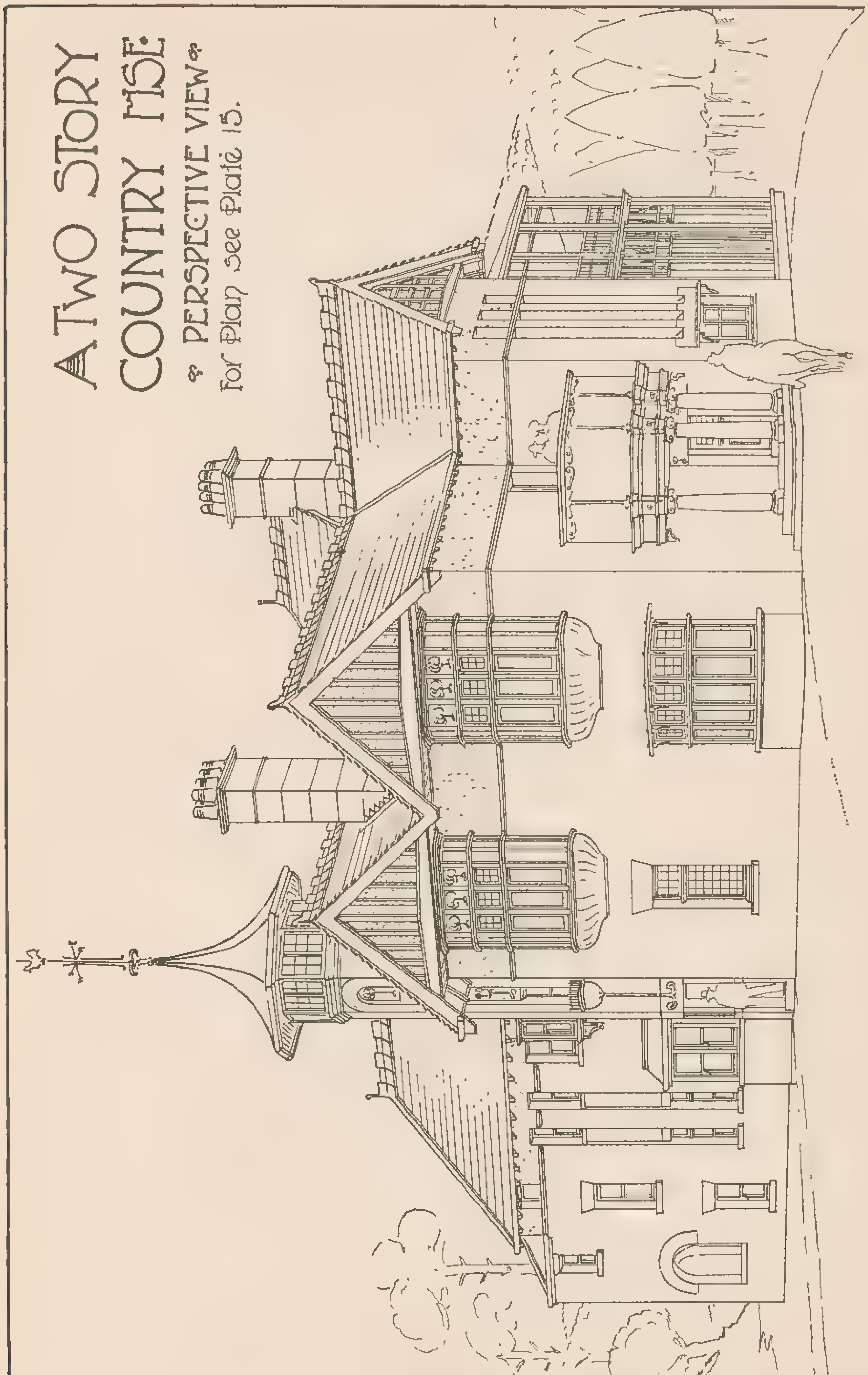
Under the kitchen a cellar is arranged, approached by a small stair just outside the kitchen door.

Beyond the scullery a series of stores is arranged, and two maids' bedrooms with bathroom attached.

The sleeping apartments at the northern end of the plan consist of a large best bedroom, with dressingroom, fitted with bath and lavatory basin; and three other bedrooms, with separate bathroom; and a nursery, which opens out into a large, sunny play verandah for children. This verandah is enclosed with balustrading, through which a small gate leads to the long northern verandah, 11 ft. wide.

The general treatment and finish is of the simplest kind, but substantial throughout. The ceilings are 12 ft. high, with 11 ft. for domestic offices


A TWO-STORY COUNTRY HSE.
GROUND FLR. PLAN. FIG. 1.
FIRST FLOOR PLAN. FIG. 2.
SCALE OF FEET
BAKERY
FUEL
LARDER STORE
SCULLERY 17×14
RANGE
KITCHEN 22×19
PANTRY
DINING ROOM 24×18
VERANDAM
MORNING ROOM 17×15
BACK VERANDAM
COAT ROOM
OCCASIONAL BED ROOM
PASSAGE
STORE
HALL 16ft wide
PORCH
LIBRARY
DRAWING Rm 18×18
PORTICO
ENTRY
MAID
LINEN & SEWING
BATH Rm
DRESSING Rm
BALCONY
BEST BED Rm 24×18
BAY
BED ROOM 17×15
PASSAGE
LAVTY
BACK STAIR
MAIDS BATH
GALLERY
UPPER PART OF HALL
TOWER STAIR
BED ROOM
BED ROOM 18×18


A TWO STORY
COUNTRY HSE
PERSPECTIVE VIEW
For Plan See Plate 15.

The walls are of hollow brickwork, and the broad, low-pitched tiled roof covers right down over the verandahs, without break of eaves, as seen in the small perspective given.

A Two-story Country House.—Plates XV. and XVI. show plans and perspective respectively of a two-story country house.

This house shows spacious accommodation upon a compact plan, self-contained and grouped to look well from all sides.

In a design of this character, where the site is ample, the designer need not be hampered, as in a suburban allotment, in having to make a front. All elevations should be alike truthfully and substantially treated.

Turning to the ground floor plan, fig. 1, it will be seen that the chief entry is through a portico at the S.E. angle of the block. This leads into a large and lofty hall, 16 ft. wide, which extends some 43 ft. back, with a broad staircase at the western end leading to the gallery above. About half of this hall runs the full height of the two stories of the building, and is lighted at the eastern end with long narrow windows, under which a low seat is placed, from which a good view of the garden and approaching drive may be obtained through a range of low windows.

A secondary entry is through a porch on the south side, which leads through a short passage to an occasional bedroom. Beyond is a coat room, with wardrobes, &c., where clothes may be changed before entry is made into the main parts of the house, this being a convenient arrangement in a country house.

The drawingroom is approached off the hall through a broad arched opening. This room has a bow window with southern outlook. The library is next, also with a southern aspect, and having the fire-place specially arranged near the window, so that the occupant may sit near the fire and yet enjoy the view obtainable from this aspect.

A morning-room, with eastern and northern aspect and door to verandah, is pleasantly arranged at the N.E. corner of the hall.

The diningroom is a large apartment, 24 ft. by 18 ft., with long, low, square bay at northern end. From this room, also, there is a door to the verandah. A sideboard recess is placed on the western side of the room near to the serving drum from the pantry. This pantry runs the full width of the kitchen, and is 8 ft. wide, and well equipped with glass-fronted cabinets, cutlery and plate drawers, tables, sink, &c. Beyond is the kitchen, 22 ft. by 19 ft., with range fitted with hot-water service.

Off the kitchen is the scullery, with exit to a back verandah. A bakery and baker's oven complete the western end of the plan. A back stair leads to a large basement for storage purposes, consisting of general store, wine-cellar, and larder.

The first floor, fig. 2, is given over to sleeping apartments. There is an ordinary bedroom over the drawingroom and a suite of rooms on the north, consisting of best bedroom, with dressingroom and private bathroom and lavatory. A door off the best bedroom leads into another bedroom over the morning-room, which is also approached from the gallery. Another bedroom, near the tower, has a dressingroom attached to it, and from these apartments there is a small stair up the tower to look-out above the roof ridge. This look-out has a practical use in case of bush fires, such an elevated position being useful in locating an outbreak. A second bedroom is also shown on the first floor.

The maids' quarters are cut off from the general apartments by a half-glass door and screen. These quarters consist of bathroom, sewing room, and linen room, with back stair to domestic offices below.

A useful housemaids' lavatory is arranged next the maids' bathroom, consisting of a small apartment fitted with slop hopper, sink, pail, cupboards, &c.; here hot and cold water is laid on, and lead-covered floor, properly graded, allows of the whole place being periodically flushed out.

The general building is of brick, with freestone work to portico.

Under the eaves, above a course of molded bricks, the walls are

roughcasted, the gables being of heavy half-timber work. There is a slate roof, with tile ridging.

All the drainage is arranged as to a town house, and served by a septic tank system of sewerage disposal, placed at some distance from the house, with the effluent discharging into an adjacent creek.

An efficient water supply is obtained by well-sinking, and a full service made available by pumping, storing, and reticulating by pipes all over the house. A perspective is illustrated upon Plate XVI.

CHAPTER VI.

TOWN BUILDINGS—OFFICES, BANKS, SHOPS, HOTELS.

OFFICE BUILDINGS.

No inconsiderable percentage of city buildings are those required for office and business use, as apart from storage or manufacturing purposes, and with these buildings we have briefly now to deal.

In the planning, financial considerations will usually be found to determine the amount of accommodation to be provided and the number of stories to be built, while city building regulations will be found to govern thickness of walls and general character of construction. Should a building be in different tenancies, with distinct entrances, the usual rule is that such buildings must have horizontal separation *i.e.*, the portion of the building entered and administered from one entrance must be cut off from the other portions by means of fire-proof flooring, practically making of each portion a separate building. This is not always enforced, but is a reasonable precaution in case of fire, and is a law in some of the Australian cities.

Light is of the very greatest importance in an office building, and must, from the very outset, affect the disposition of the plan. Unless a corner site be chosen, a city building has usually to depend, in a very large degree, upon front lighting, or front and back lighting, the party walls being exempt from use for lighting purposes. This often leads to the introduction of "light areas" as a means of lighting the interior, and especially so in positions where a number of small apartments require separate and direct light and air.

Plate XVII. is designed to show the disposition of light areas applied to three different building sites.

PLATE XVII.

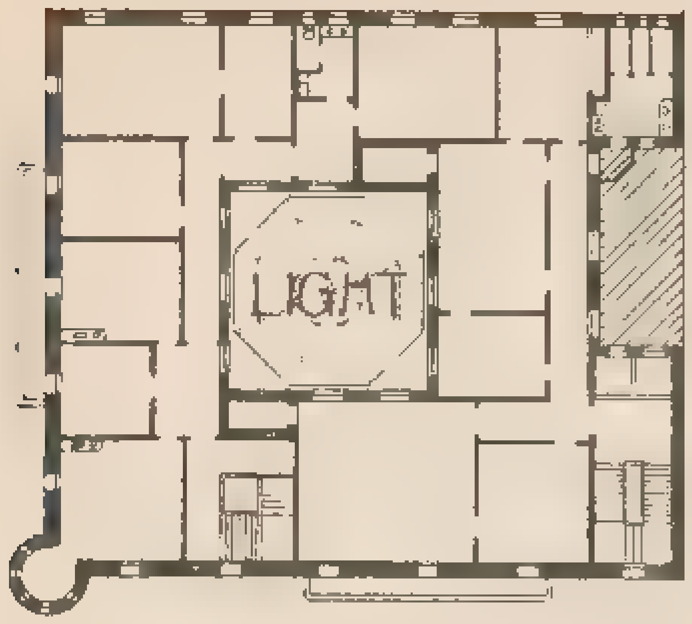


FIG. 1.

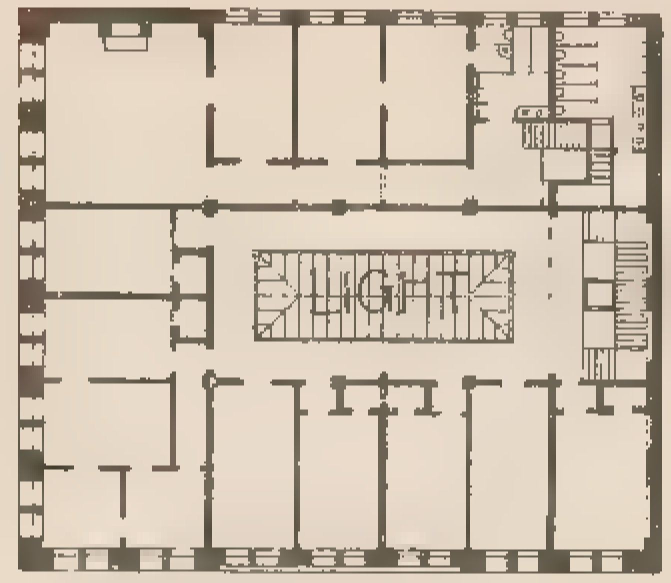


FIG. 2.

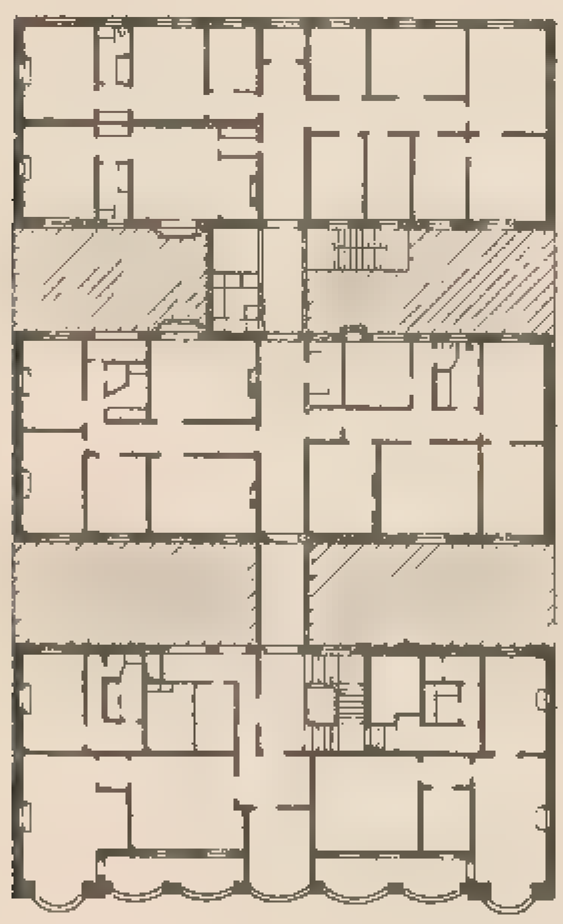


FIG. 3.

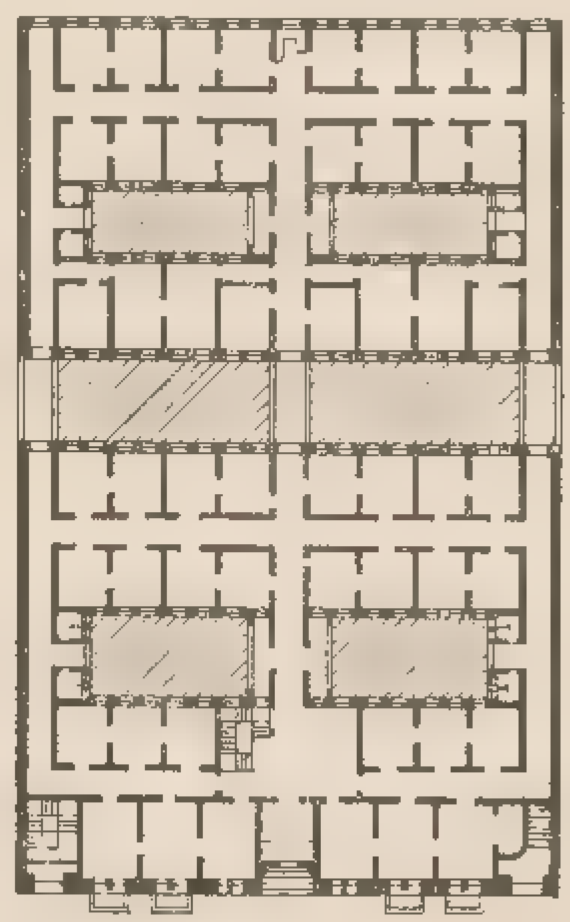


FIG. 4.

FIG. 5.

FIG. 6.

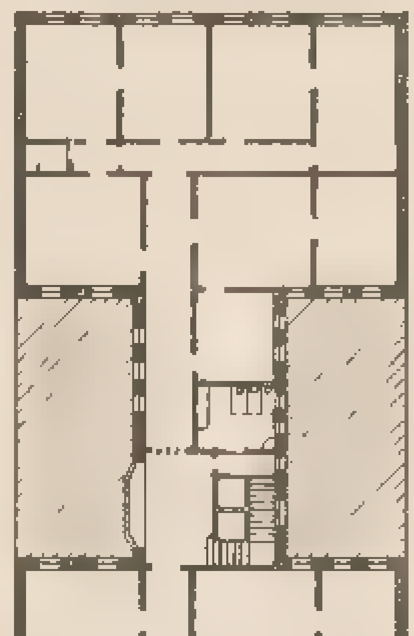


DIAGRAM SHOWING
DISPOSITION OF
LIGHT-AREAS
APPLIED TO
THREE DIFFERENT
CITY BUILDING
SITES.

Fig. 1 is a large corner site, with a frontage to two streets and a back lane. Here it is necessary to light the one remaining side exempted from direct lighting, and this is done by the introduction of a rectangular-shaped area. In the centre of the block a glass roof is shown, marked "light," lighting the centre portions of the block. Glass-roofing in this way is sometimes adopted, so that the ground floor apartments may extend over the whole area of the ground floor, the light areas being roofed at ceiling height and extending up open to the upper floors.

Fig. 2 shows the same site with apartments so arranged as to require only one light area, glass-roofed over.

Fig. 3 shows another site. This site has an extensive depth, and front and back frontages to streets, but no side light. Here the shading shows how areas are introduced to light the interior areas which, in this case, extend the full height of the building and practically divide the building into three blocks.

Fig. 4 shows the same site differently treated. In this case the apartments are somewhat smaller, and six light areas are required.

Figs. 5 and 6 illustrate a much smaller site than the other two. Here only front and back lighting is available. The figures show two ways of internal lighting—one by means of an angle-shaped area, and the other by two rectangular areas. These areas are shown by the shading.

Areas should offer good reflected light, and for this purpose should be carefully regulated in size to suit the height of the building and the normal intensity of light, so that light and air may reach the lowest placed rooms. For the purpose of reflection the outer walls are sometimes lined with white glazed tiles or bricks.

In the general construction of an office building, fire-resisting construction is undoubtedly best; but, such methods being sometimes found too expensive, a compromise may be made by laying in all passages and stairs of fire-resisting materials.

Partitions require to be carefully considered, and some of them at least usually require to be so arranged as to be movable, to suit

possible tenants, without interfering too much with the structural work of the building.

All means of communication should be direct elevators and stairways ready to hand and in direct incoming ways.

The sanitary offices should be grouped on each floor, and all passage floors and dadoes finished in washable material.

External Design.—In external design the office building has its own peculiar difficulties, accentuated usually by being confined to a "front." Such a mode of treatment is, of course, absolutely necessary where only one street frontage exists. It is only when the building is upon a corner site that the grouping can be directed satisfactorily towards giving a better feeling of distinctive mass grouping. Plain, bare party walls often produce crude resistance in this class of designing, especially in positions where adjoining buildings are, as they invariably are in our cities, of differing heights. Plates XVIII., XIX., and frontispiece give elevational designs for the plans shown upon Plate XVII.

Plate XVIII. is a design in reinforced concrete for the main front of the plan on Plate XVII., fig. 5.

The building is a five-story one, with basement, the ground floor being left free as a large, open business chamber, and the top floor arranged for use as a fine art gallery.

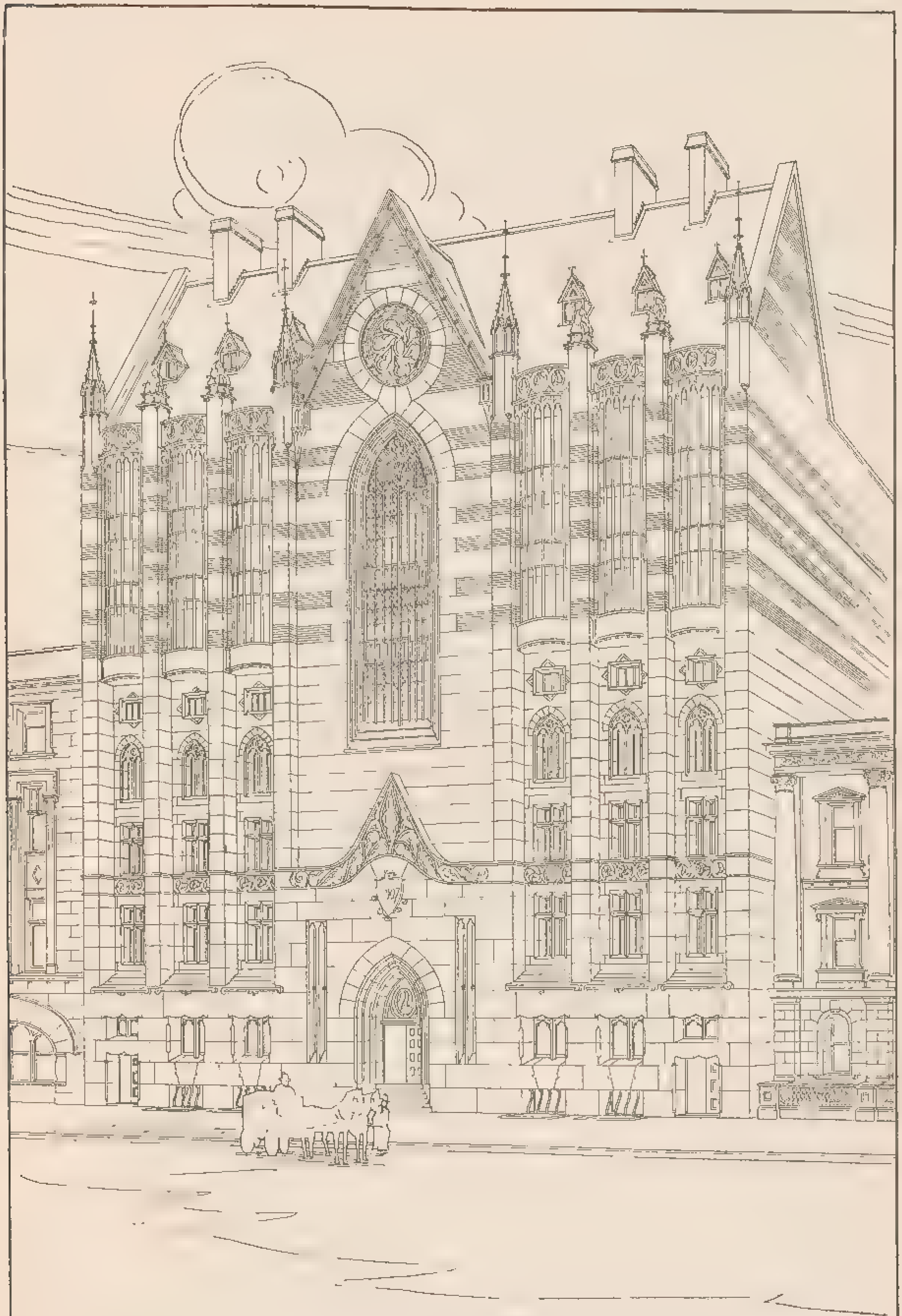
Opportunity is given by the position of the entrance to emphasize the mass above the door by a vertical treatment of line, the other portions of front being left severely plain. The roof is flat, which gives horizontality to the sky line. A balcony is arranged to serve the first floor windows, which, while of value as a useful adjunct to the accommodation, gives that projecting relief which the large, flat mass of the walls above requires.

The design, as a whole, is treated in the modern manner, and aims at giving the exact amount of light required, with simplicity and directness of finish.

Plate XIX. is a treatment for the elevation of the main street frontage of fig. 4 on Plate XVII.

PLATE XVIII.

DESIGN FOR CITY BUSINESS PREMISES SHOWING STREET FRONT



DESIGN FOR CITY OFFICE BUILDING

The design is in the Gothic manner, and is for a seven-story building, with sub-basement and a high-pitched roof. There are three entrances—two leading direct from street pavement to basement. The main entrance is grouped in the centre of the elevation, which, as a whole, is treated so as to offer some contrast of repose when compared with the remaining portions of the front.

The upper apartments on the wings have open balconies behind long stone pillar shafts ending in open tracery work above.

The front is designed to be built in freestone in two tints, the upper portion of the walls being constructed in bands of varying tones. The high roof is covered with slates, and some picturesqueness of sky line is obtained by the ornamental pinnacles and centre gable.

The frontispiece plate is a design for the angle site building shown on Plate XVII., fig. 1.

This design is specially arranged for a hot climate, where light glare has to be reduced and generous balcony and shade treatment provided.

BANKS.

Banks are essentially town buildings, and often occupy very important and prominent sites in Australian cities. They need in their planning well thought out consideration, not only that they may merely look well, but that the intricacies of planning, peculiar to this class of building, should be happily blended, and so arranged as to give naturalness of grouping, with dignity and substantiality of general mass.

The large majority of banks are, in a degree, residential, and divide themselves into three classes of accommodation—viz., the public part, the working office part, and the residential part—and how to blend and work these properly is the problem of bank design.

The following is given as an example of the accommodation

allowed for in a prominent city bank, and may be taken as a guide indicating the class and amount of accommodation usually provided in a building of the larger class.

A centrally situated banking chamber with a floor area of 2,500 super. feet, containing space for public and office space for three tellers, two receiving titles clerks, four ledger keepers, two pass-book clerks, two journal clerks, two bill clerks, with small public counter; one clerk for fixed deposits, drafts, check books, &c., with a small public counter; two exchange clerks, with a small counter for other bank clerks; two corresponding clerks, with typewriter tables; also space for a letter clerk, with copying presses, return and security clerk, &c.

The accountant's office is in touch with the public, yet is so arranged and elevated as to overlook the whole of the office.

A well placed and amply spaced manager's room, with waiting room and branch inspector's room, is attached.

The strong-room is about 160 ft. super., with one-third divided off by a steel grille.

Store-rooms (fitted with shelves) for stationery and vouchers of about 200 super. feet. Ditto for old papers, &c., about 400 super. feet.

Luncheon room for bank officers, with hat and coat room, cycle room, &c.

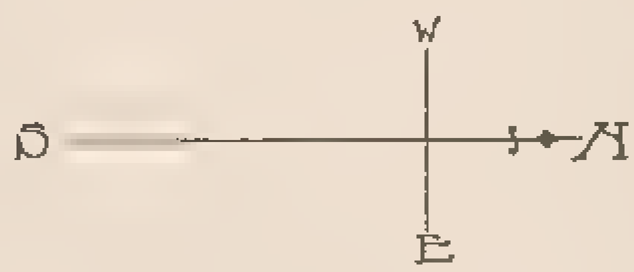
Fuel store, separated lavatories, W.C.'s, &c., and manager's residential quarters.

Such a building may be planned upon land having a frontage of about 45 ft. with a depth of about 120 ft. A corner site is usually preferred, as giving greater accessibility and also facilities for direct lighting, and the varied approaches necessary for public, manager, clerks, tradesmen, &c.

As an illustration of a small bank design, Plate XX. is given, which illustrates a building upon a narrow but deep corner site.

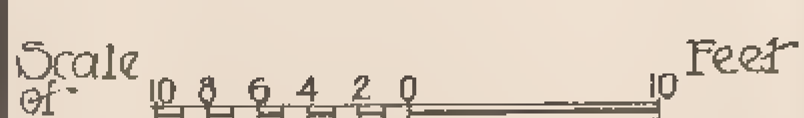
The entrance to the public portion of the bank is upon the corner, where a screen lobby is arranged. This is a very important

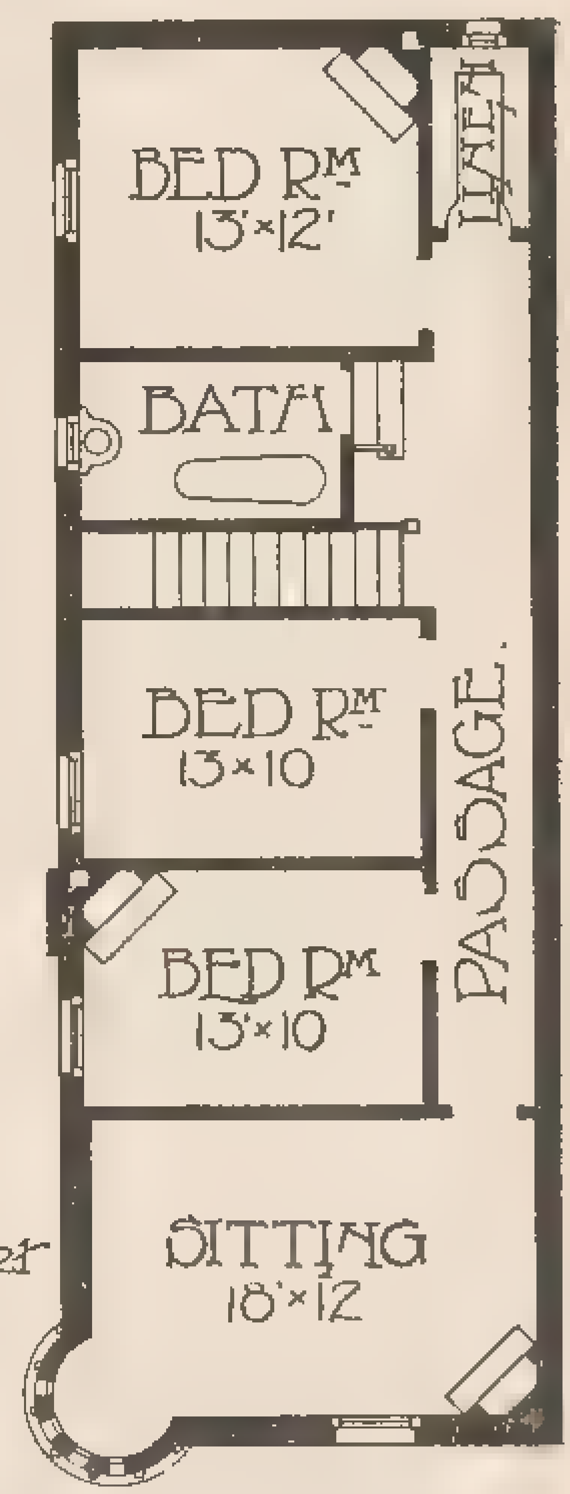
Perspective Sketch.



A SMALL BRANCH BANK

GROUND PLAN





FIRST FLR PLAN

feature, as wind and dust require to be counteracted, yet, in such a way as to give easy and safe ingress and egress. A space of about 750 ft. super is given over to the working part of the bank, which in this case consists of office, waiting-room, manager's room, strong-room, store, lavatory, &c.

The manager's private entrance is from the side street, and the accommodation provided on the ground floor is hall, private way into banking chamber, diningroom, kitchen, wash-house, fuel, W.C., back verandah, and yard, and on the first floor a front sitting-room and three bedrooms, bath, and linen store, with facilities for a brick extension over the kitchen, for other bedrooms, if required.

At the back of the site, next to a right-of-way, a clerks' yard is arranged, with sanitary accommodation.

The perspective shows the external design of the building carried out in stone and brick, with slate roofing.

Strong Rooms.—In all banks the construction of the strong-room must be skilfully considered. These may consist of specially manufactured armoured plate enclosures, or of some form of steel reinforced concrete. In large strong-rooms extra security is sometimes obtained by building the room entirely of close-packed steel railway rails bedded in concrete; or a boiler plate case may be made, lined on two sides with brickwork. In any case, the doors and grilles to the rooms require to be of special make and securely built in. All shelves and fittings should be fireproof, and some form of effective, yet safe, means of lighting and ventilation requires to be designed.

SHOPS.

Generally.—The planning and building of shop premises is a class of work that comes frequently within the scope of the designer, and although the actual planning of such premises is too dependent upon various business requirements and questions of site, area, and size to allow of fixed rules being laid down, still

there are important questions of detail, which are more or less met with in every problem, that may here be briefly touched upon.

Lighting.—This class of work presents its own peculiar difficulties, not the least of which is the question of adequate lighting.

Shops are generally required to occupy street sites abutting directly on adjoining owners, and it is only when a corner site is chosen that the problem of side-lighting is somewhat eased.

For certain classes of business the front windows, though adequate for display, are often so occupied with stock as to offer but limited light to the shop itself, consequently the shop frequently has to rely upon other means of lighting, such as a centre well through the upper floor or floors with lantern over, or, if the shop be of shallow depth, back lighting or otherwise internal area lighting.

One-story premises are more easily dealt with than two or many storied structures, as satisfactory lighting can generally be obtained to any distance back from the street frontage by half-glass saw-tooth roofing.

A device which finds increasing favor for shop-lighting from the front is to so plan the front windows as to create shallow lights above the display portion of the window and above verandah height. This lets in a flood of high light to carry back into the shop proper, unobstructed by window display.

In this it may be remembered that beyond a certain height, as from 11 ft. to 13 ft. from the pavement, the display window is of but little value, as the eye of the shopper is generally directed only within the range of a normal height from the pavement.

Intermingled with the question of adequate lighting must come the question of "direct sunlight screening," for, if the premises be sufficiently lighted for the dull days of winter, certain screening devices will be necessary for the direct glare of summer, and this must not be forgotten, especially where goods for sale may be of such a nature as to be subject to the fading influences of strong light.

Elevational Design.—In designing the shop elevation three things should be borne prominently in mind. Firstly, adequate lighting; secondly, spacing for permanent advertisement; and thirdly, the effect of adjoining buildings upon the new structure.

The deeper the premises the larger must be the provision for front lighting, which may lead to almost a pier-like treatment, the greater area of the front being glass, but, whatever the arrangement, some happy balance of proportion should be secured.

Advertising has become so vital a part of modern business that provision for its proper and permanent display should from the outset be made upon the front elevation, otherwise unsightly boards may be afterwards erected, covering up the architectural features. There is no reason against proper spacings being left in the elevation for this purpose, which can be either carried out by painting or by metal lettering upon tiled or marble surfaces, or by wrought-iron sky signs, all of which devices are best made and considered as part of the permanent structure.

Adjoining premises will always affect any design, and such adjoining work, if any, should be drawn and plotted to scale, upon the paper in position, before the designing of the new elevation is started, and the new work designed under the influence of the old. In this way questions of height, projection, and style will have full consideration.

In Plate XXI. is shown a detailed elevation of a two-storied shop for a drapery firm, having a frontage of 20 ft., with a southern aspect.

The ground floor height is 15 ft., and the front floor height 12 ft.

The shop window case is kept down to within 12 in. of the footpath, the lower portion of plate-glass rising therefrom to a height of 10 ft. The space above this is used to directly light the shop over the top of the window case. A deep fascia is secured by tiling the space above the glass right up to the sill height of the first floor windows, upon which raised metal letters are secured. A

similar arrangement is planned near the parapet for the word "Drapers."

The general work of the front is in red brickwork, with buff freestone dressings, the tiles being iridescent blue, with gilt letters. There is a tiled roof, the flanking turrets being covered with green oxidized copper.

The Shop Window.—In considering the design of the shop front windows a few hints may be given as to arrangement.

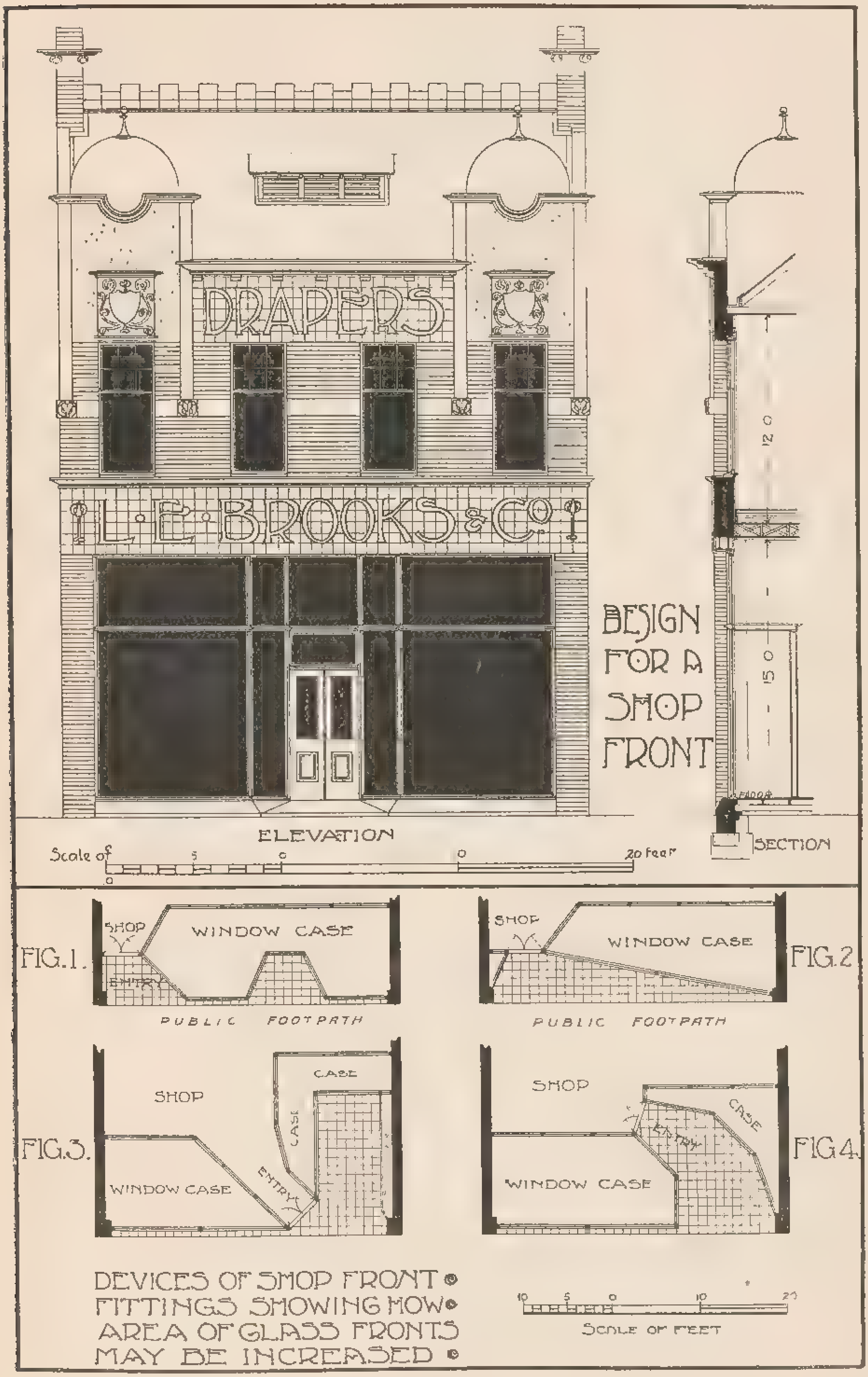
By reference to the figures upon the lower portion of Plate XXI. it will be seen how, in various ways the actual length of window glass may be increased to give greater display space to the public.

Fig 1. shows how the main portion of frontage may be recessed, an arrangement which in cases of wide frontages may be repeated again and again.

In fig. 2 is an arrangement for throwing the whole of the window at a flat angle from frontage line. This has the double advantage of increasing the length of glass frontage and making extra space in the front of window. In cases where footpaths are very narrow and traffic heavy, a somewhat similar device to this may be resorted to—viz., the setting back of the window case several feet parallel to the frontage line, and by this means throwing a certain portion of the frontage entirely into the footpath.

Fig 3 sets out a plan to further increase the window case frontage area, and if there be good depth in the shop, some plan of this kind may be found of great advantage. A modification of the same idea is seen in fig. 4, where long show windows are planned on both sides of a generous entrance lobby.

Window Casing.—As each business will have its own method of window display, so will the design of the window casing be modified accordingly, but it may be noted how markedly of late years the tendency has become to open out the shop front in every possible way. As an evolution from the old type of "shut in" and "shut up" work the change has been very marked; and further, in carrying out this idea of openness, the demand has


DRAPERS
L·E·BROOKS & Co
DESIGN FOR A SHOP FRONT
ELEVATION
Scale of 5 0 0 20 feet
SECTION
FLOOR
12 0
15 0
FIG. 1.
SHOP
WINDOW CASE
ENTRY
PUBLIC FOOTPATH
FIG. 2
SHOP
WINDOW CASE
PUBLIC FOOTPATH
FIG. 3.
SHOP
CASE
CASE
WINDOW CASE
ENTRY
FIG. 4.
SHOP
CASE
ENTRY
WINDOW CASE
DEVICES OF SHOP FRONT FITTINGS SHOWING HOW AREA OF GLASS FRONTS MAY BE INCREASED
10 5 0 10 20
SCALE OF FEET

increased for lowering the sill, and if a basement be not formed in front requiring stallboard lighting, the sill may be brought down nearly to the footpath level.

In this pursuit of openness, shutter devices are in a large number of cases decreasing or disappearing altogether, the vast increase in the brilliancy of street lighting having, at least in the important towns, worked a marked change.

Shop front fitting has to a great extent become specialized, and in designing high-class work consideration should be given to obtaining the most effective and practical arrangement consistent with available funds. By the vast improvements effected of recent years in sheet metal working, nickeling, and copper finishing, light sashes with metal covering may be substituted for wood molding and metal lettering on glass, whilst tiles or marble may be designed in place of the old style of brasses.

Dust Exclusion and Ventilation.—Dust exclusion and adequate ventilation should be fully considered in the window case, which, for most businesses, requires to be entirely enclosed and self-contained, all back doors being tightly fitted. In ventilating, the ventilation of the case should be entirely apart from the shop, and if the serious nuisance of winter glass condensation is to be avoided, proper tube vents should be inserted in the ceilings, carried right through the building, and finished above the roof with exhaust cowls.

Ground Flooring.—In actual practice, the ground flooring of the shop often gives grave trouble. In any buildings close bounded at the sides and with but small means of venting from the street or back, wooden floors are most liable to suffer from dry rot, and also from wet rot when the ground is not, as it should be, asphalt covered and kept dry. This serious curtailment of the life of wooden floors leads to the recommendation, where possible, of such a material as pure mineral asphalt on concrete being used in place of wood flooring. This floor obviates all danger from decay. The material is highly lasting, and not of so cold a nature as tiles or floors having cement as a basis of their mixture.

Street Verandahs.—In southern aspects verandahs are not as a rule required, but where they are adopted they are subjected to the laws of local authorities, and in some of the leading cities a standard pattern is insisted upon.

The verandah, like the structure, may be designed with permanent advertisement display, and should be strong and stable to withstand high wind pressures.

In the use of cast-iron posts there is a serious danger, for in case of a heavy and sudden blow, such as may occur from a runaway horse, an irreparable fracture may occur sufficiently serious to tear down the whole of the verandah. If cast-iron posts are used they should, therefore, have inserted through them a welded tube core and the interstices filled with fine cement concrete. In this way, though a sudden fracture should occur, the core will temporarily carry the weight.

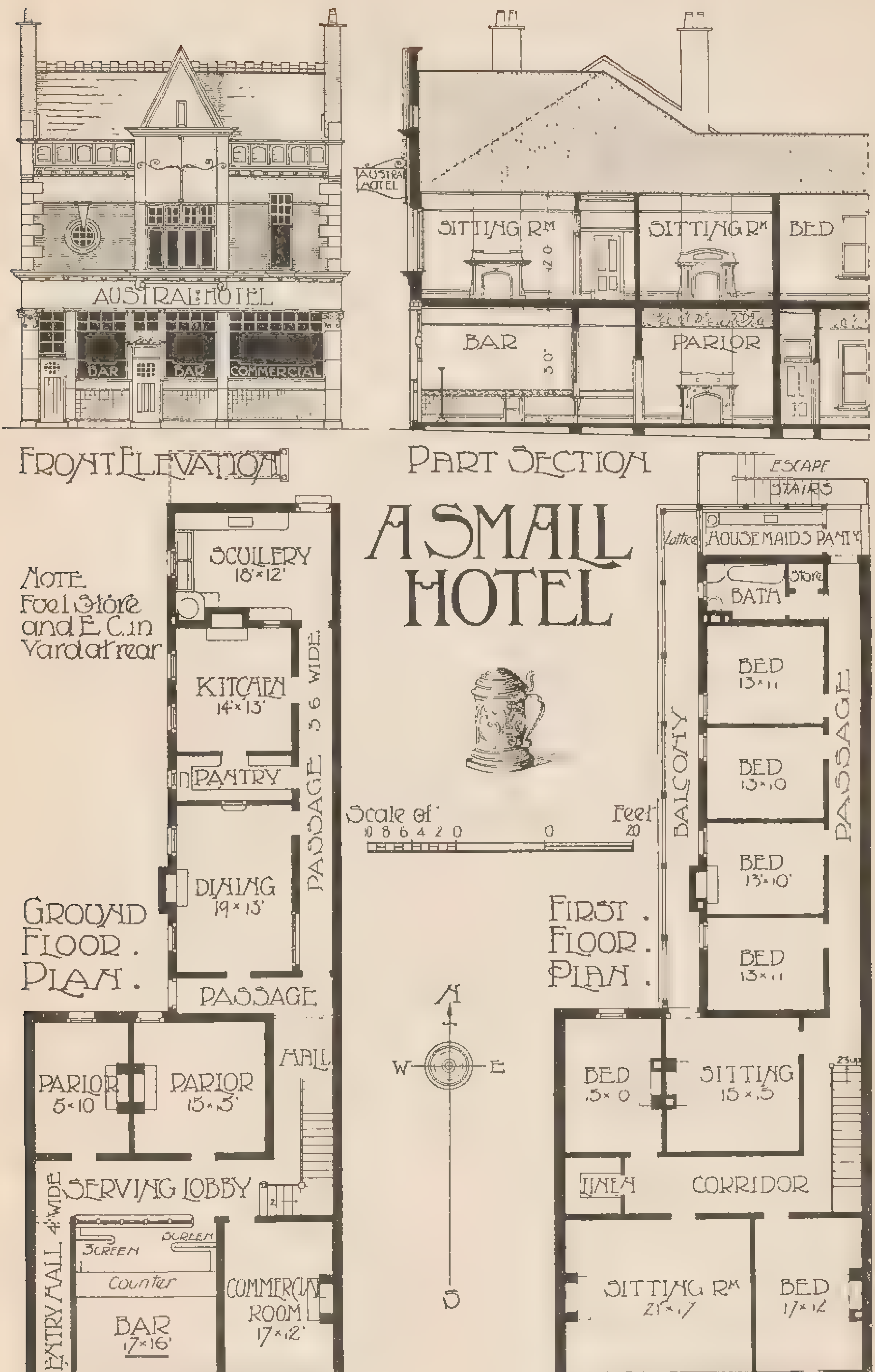
Skylights, too, are a source of danger if not strongly constructed and holding heavy glass. In these the wired plate, which is able to withstand reasonable pressure should anyone step upon it, or, in case of hailstorm, offer some safety to the persons who may be under the shelter of the verandah, is best.

HOTELS.

New hotels are subject to the approval of the licensing authorities, and plans and designs, clearly illustrating any proposed scheme, usually require to be submitted for approval before a building is commenced, in addition to which the public health authorities in some of the States have power over hotel structural arrangements.

It is highly important that, in hotel design, the idea that such a building is required for semi-public purposes should be prominently before the designer, and a well-arranged degree of privacy within the residential and sleeping portions of the house secured, while due prominence is given to the more public portions.

Hotels differ very widely indeed in character, and range from the


AUSTRAL HOTEL
BAR
BAR
COMMERCIAL
FRONT ELEVATION
AUSTRAL HOTEL
SITTING Rm
SITTING Rm
BED
BAR
PARLOR
PART SECTION
A SMALL HOTEL
NOTE
Fuel Store and E. C. in Yard at rear
SCULLERY 18'×12'
KITCHEN 14'×13'
PASSAGE 3' 6 WIDE
PANTRY
DINING 19×13'
GROUND FLOOR PLAN.
PASSAGE
HALL
PARLOR 15×10
PARLOR 15×15'
SERVING LOBBY
ENTRY HALL 4' WIDE
SCREEN
SCREEN
Counter
BAR 17×16'
COMMERCIAL ROOM 17×12'
Scale of Feet
10 8 6 4 2 0 10 20
N
W
E
S
ESCAPE STAIRS
Lattice
HOUSE MAIDS PANTRY
BATH
Store
BED 13×11
BED 13×10
BED 13'×10'
BED 13×11
BALCONY
PASSAGE
FIRST FLOOR PLAN.
BED 15×10
SITTING 15×15
LINEN
CORRIDOR
SITTING Rm 21'×17
BED 17×12

out-back small weatherboard hotel, of very limited size, to the large, elegantly furnished city or residential hotel. Between these two extremes lies a broad range of very diverse buildings, some designed on open sites in the country, where land is more readily available, and where, as in market towns, very full yard and stabling accommodation is required, and others in busy city streets closely surrounded by other buildings.

Two designs are here given of hotels—Plates XXII. and XXIII. —one upon a closed-in site, and the other upon a corner.

Plate XXII. shows a plan upon a 36 ft. street frontage, closed in between adjoining properties. It has a southern aspect and a right-of-way access at the rear.

Two entrances are arranged, one direct into the bar, and the other at the side, the accommodation upon the ground floor consisting of a 17 ft. by 16 ft. bar, with a serving lobby at the rear, giving general access to the house. A commercial room and two parlors on the ground floor group around the bar, and this public part of the house is cut off on the one hand from the diningroom and domestic offices, which are arranged at the rear of the main building, and which are in themselves self-contained, and on the other from all the bedroom accommodation, which is grouped together upon the first floor.

In hotels no sleeping apartment should contain less than 1,200 cubic feet of air space, and each room should be well and directly lighted, and have ample means of ventilation, apart from the windows. The upper floors, wherever possible, should be of fire-resisting materials, as certainly should all the staircases, and all floors above the ground floor should have alternative means of escape—*i.e.*, escape in more than one direction. Fire hydrants, hoses, fire buckets, &c., should also be provided, with ready access in case of fire.

In the design under review the smallest bedroom is 13 ft. by 10 ft. In some hotels the smaller rooms are made 10 ft. by 10 ft. by 12 ft. high, which gives the minimum of cubic space for a single

bed. Here the accommodation, though small, is generous in room spacing. There being no underground drainage, the sanitary fittings are kept well to the rear of the premises, and a housemaid's pantry with slop sink is planned in semi-open louvred annexe at the end of the first floor passage and next to the bath.

A balcony runs along in front of the rooms facing west, cantilevered out from below.

The section shows the general system of height and internal treatment, and the elevation shows a brick and terra-cotta treatment of the front. A hot-water supply system to this building is illustrated in "Hot Water Engineering," Chapter XVIII.

Plate XXIII. shows a large hotel for a country town upon a corner site. Here the bar is upon the angle at the junction of two streets, the door being screened under a round turret feature. The general hotel entry is between the bar and a front billiard-room. The accommodation upon the ground floor includes a large commercial room, with access to a garden; a bar lounge, a smoking-room, a lavatory and two small sitting-rooms, together with a large public and a small private diningroom. The kitchen and scullery are combined in one large apartment, with stores having a cool southern aspect grouped next to them. The large diningroom has the greater area of window space to the southward.

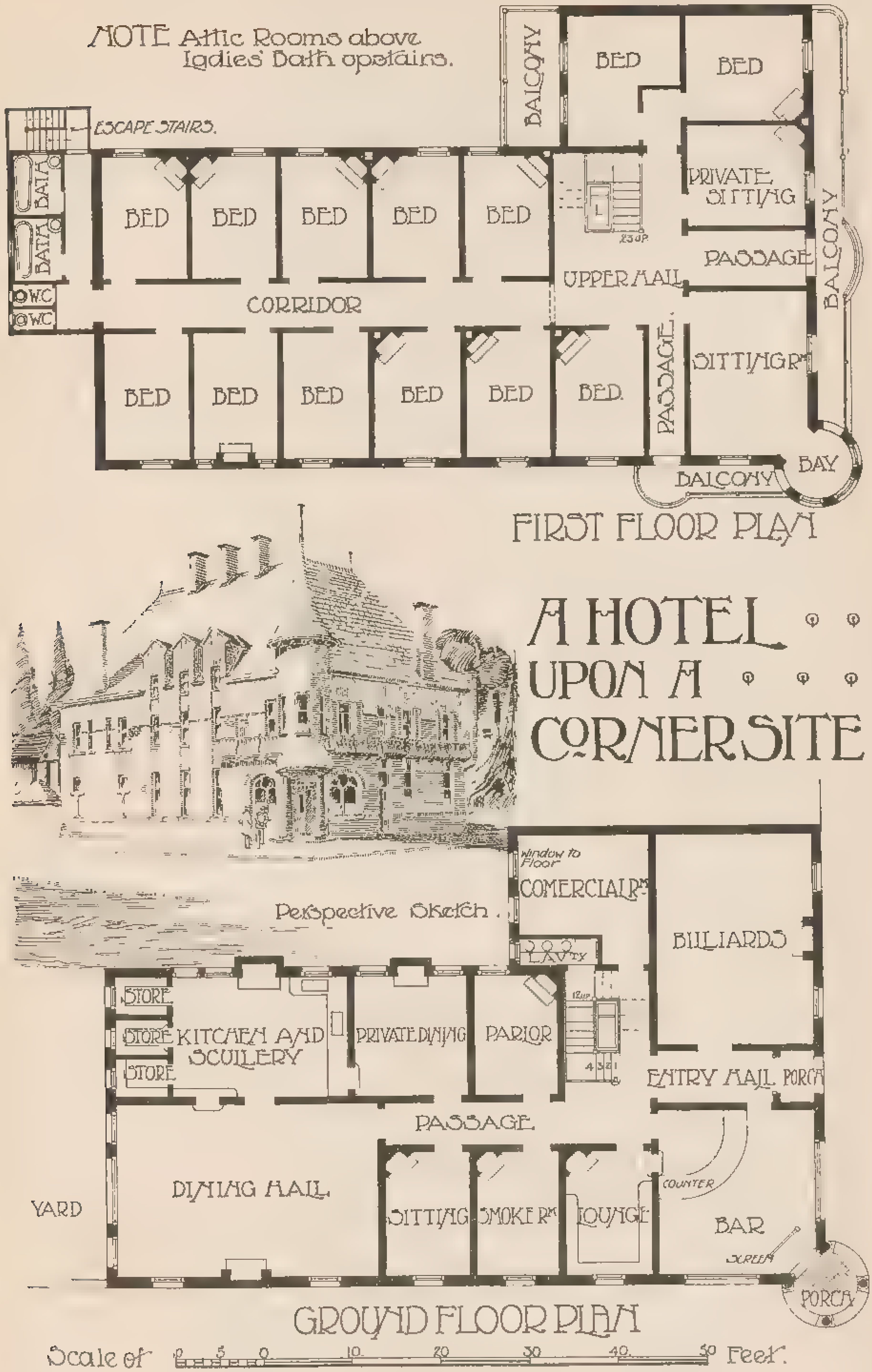
The yard, approached from the side street, could be planned with stabling, W.C.'s, stores, &c., as required.

The first floor contains 13 bedrooms of various sizes, two bathrooms, W.C.'s, &c., and two sitting-rooms, with balconies, escape stairs, &c.

In the roof space attic rooms are arranged above the plan shown.

The perspective sketch illustrates the general grouping of the design.

PLATE XXIII.


NOTE Attic Rooms above
ladies' Bath upstairs.
ESCAPE STAIRS.
BATH
BATH
W.C.
W.C.
BED
BED
BED
BED
BED
BED
BED
BED
BED
BED
BED
BED.
CORRIDOR
BALCONY
BED
BED
PRIVATE SITTING
PASSAGE
UPPER HALL
BALCONY
PASSAGE
SITTING R.M
BAY
BALCONY
FIRST FLOOR PLAN
A HOTEL
UPON A
CORNER SITE
Perspective Sketch.
Window to Floor
COMERCIAL R.M
LAV.TY
BILLIARDS
STORE
STORE
STORE
KITCHEN AND SCULLERY
PRIVATE DINING
PARLOR
ENTRY HALL
PORCH
PASSAGE
COUNTER
YARD
DINING HALL
SITTING
SMOKE R.M
LOUNGE
BAR
SCREEN
PORCH
GROUND FLOOR PLAN
Scale of 10 5 0 10 20 30 40 50 Feet.

CHAPTER VII.

MISCELLANEOUS BUILDINGS—SHEARING SHEDS, BUTTER FACTORIES, STABLES, HOSPITALS, CHURCHES.

SHEARING SHEDS.

In determining the design of a shed for shearing purposes, some estimate must be made of the average number of sheep to be shorn, and a knowledge obtained, by the designer, of the methods and general working, and the most economical and practical way of dealing with this truly Australian industry.

Great differences of opinion exist, even among men well practised in station work, as to the planning of these buildings, and especially with regard to minor details. But for general shearing purposes the plan usually resolves itself into either a side or a centre board system, each fed by pens and served with a wool room of varying size, according to the number of sheep usually dealt with.

A side board plan is one in which the shearers work in one long row. The centre board is an arrangement where the shearers work in two long rows on the same board or floor.

The process of shearing consists, broadly, in driving the sheep in from the run into storage paddocks around the shed, from which they are drafted into the building. This is rendered necessary, firstly because the process of shearing is carried on under cover, and secondly, it is highly important that the animals should be dry at the time of being shorn. To secure this latter end in damp weather the animals are driven into the building overnight, ready for shearing the next morning.

The floor of the building should be raised up so that the general work is carried on at a height of about 4 ft. 6 in. above the general ground level.

The sheep, therefore, enter the building up ramped ways into storage pens, these pens leading from one to the other into catching pens, which are next the shearing board. The shearing board is really a floor on which the men work.

The shearer takes his sheep from the catching pen, shears it (either by hand or by machinery), and passes it down into the counting pen, from which, after counting, the animals are driven back to the general run.

The fleece and wool falling from the shearers' hands is gathered up by boys and carried to the wool room. This should be a large, open, well-lighted apartment, containing wool tables, classers' table, piece-picking tables, and a series of bins wherein the various classes of wool are deposited. From these bins the wool is passed out to the press, where it is baled, and afterwards to the weighing machine. After branding, &c., it is passed out, ready for export, to the drays that back up to the outer doors.

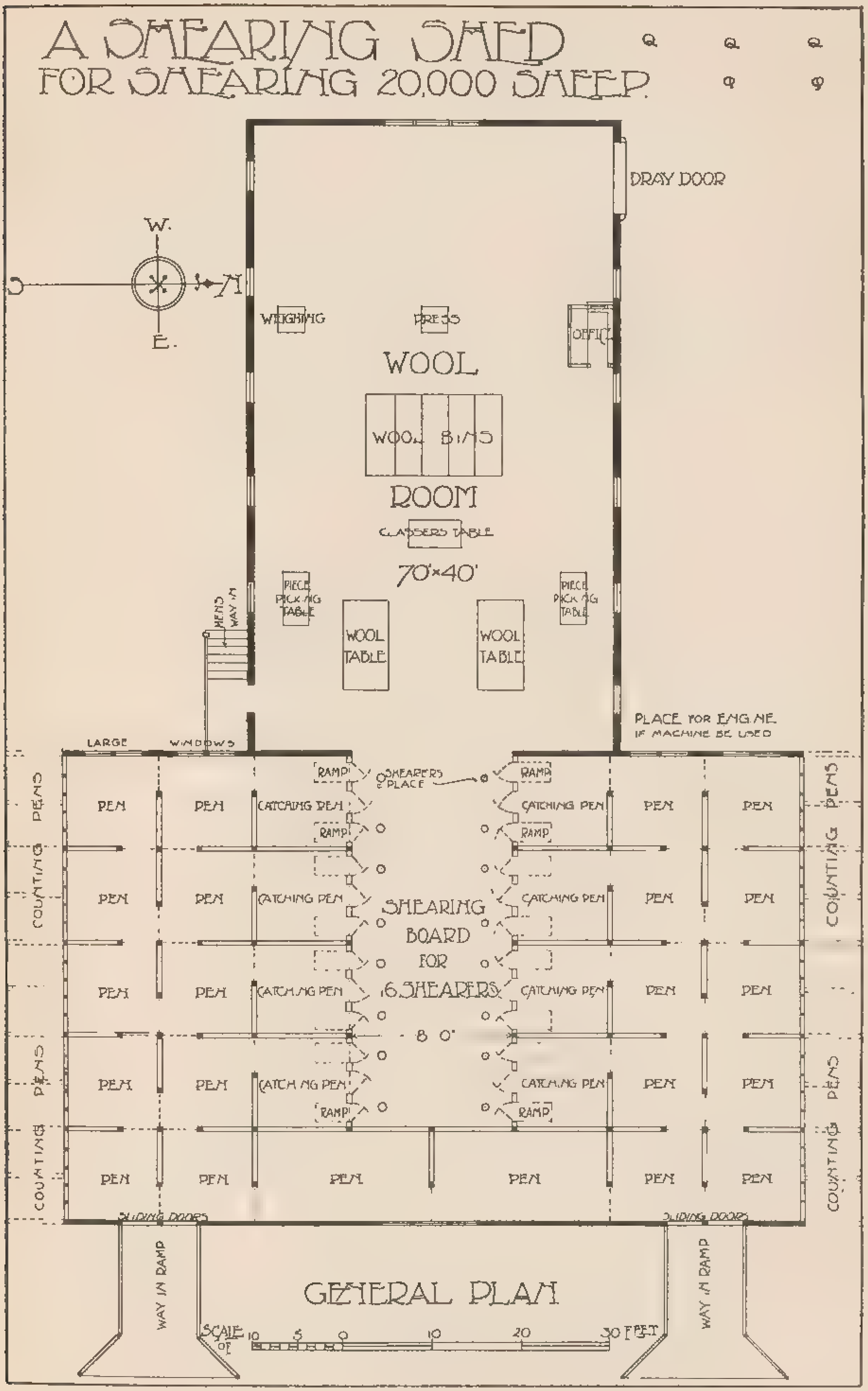
A well-considered plan should always provide for a central wool room, so that economy of space working may be secured, and needless running to and fro avoided. In very large sheds the shearing boards are best arranged to right and left of the wool room.

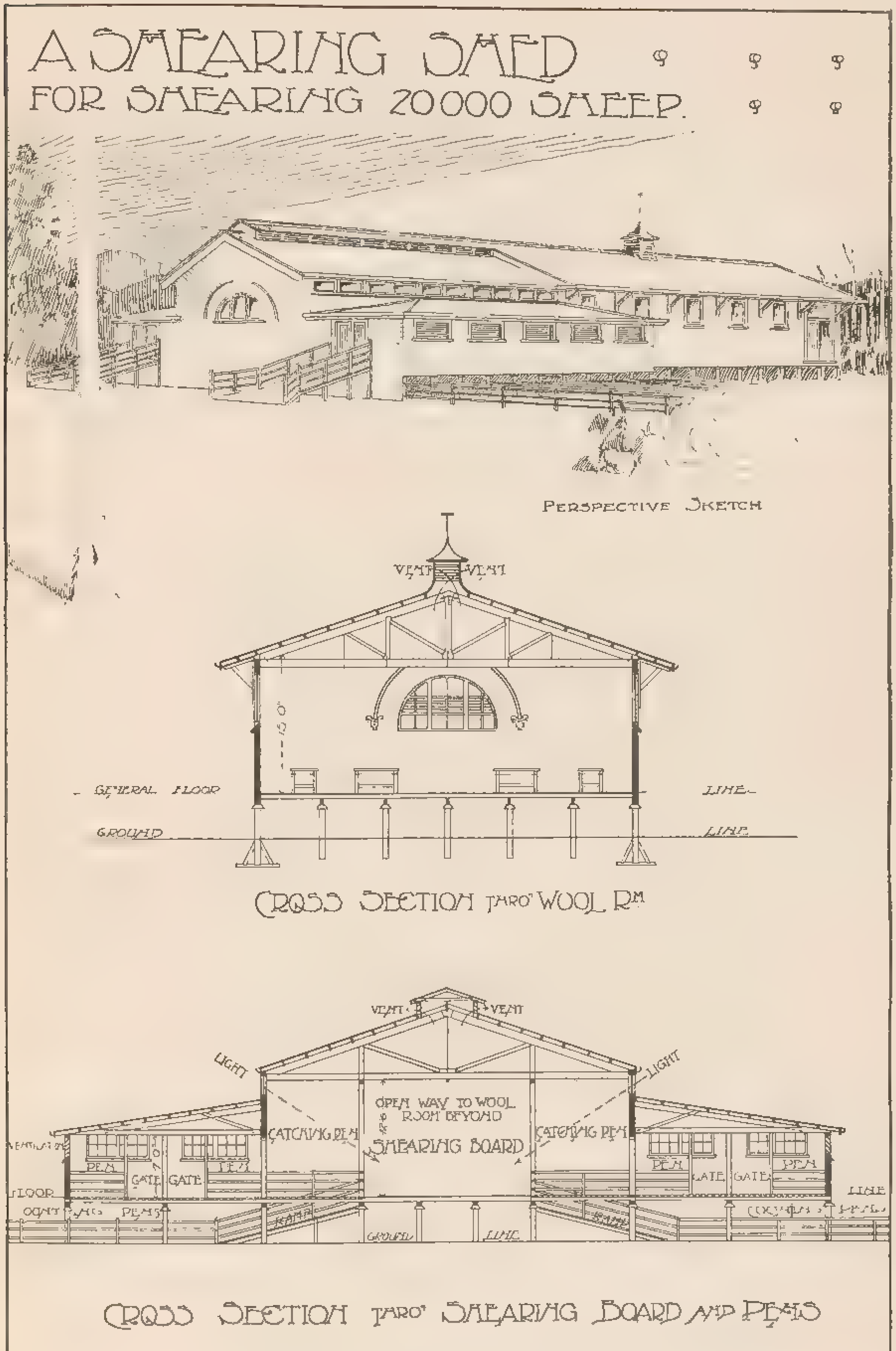
Machine shearing will also affect the plan, as provision must be made for power, either by stationary or portable steam, oil, or other power engine. The building must be so arranged to permit lines of shafting to drive on to the actual work with as little loss of power as possible.

Lighting is important, and should be ample, without glare of direct sunlight, the shearing board and the wool classers' tables being specially considered.

Ventilation, too, should be most ample, but special care should be taken, in very exposed situations, to avoid the danger of rain entering the outlets, which it is very liable to do in such isolated buildings as shearing sheds unless specially planned against.

Plates XXIV. and XXV. show a scheme for a shearing shed capable of dealing with about 20,000 sheep.


A SHEARING SHED
FOR SHEARING 20,000 SHEEP.
DRAY DOOR
W.
E.
N
WEIGHING
PRESS
OFFICE
WOOL
WOOL BINS
ROOM
CLASSERS TABLE
70'×40'
PIECE PICKING TABLE
PIECE PICKING TABLE
WOOL TABLE
WOOL TABLE
PENS WAY IN
PLACE FOR ENGINE IF MACHINE BE USED
LARGE WINDOWS
COUNTING PENS
PEN
CATCHING PEN
RAMP
SHEARERS PLACE
SHEARING BOARD FOR 16 SHEARERS
8 0'
SLIDING DOORS
WAY IN RAMP
GENERAL PLAN
SCALE OF 10 5 0 10 20 30 FEET


A SHEARING SHED
FOR SHEARING 20000 SHEEP.
PERSPECTIVE SKETCH
VENT
VENT
GENERAL FLOOR LINE
GROUND LINE
CROSS SECTION THRO' WOOL RM
VENT
VENT
LIGHT
LIGHT
OPEN WAY TO WOOL ROOM BEYOND
SHEARING BOARD
CATCHING PEN
CATCHING PEN
PEN
PEN
GATE
GATE
PEN
PEN
GATE
GATE
RAMP
RAMP
GROUND LINE
CROSS SECTION THRO' SHEARING BOARD AND PENS
SCALE OF 10 5 0 10 20 30 40 FEET

The centre shearing board is 18 ft. wide by 42 ft. long, and is spaced for 16 shearers, 8 on either side.

A series of storage pens is arranged on three sides of the shearing board, fed by "way in" ramps at the eastern end of the building, up which the sheep are driven to the general floor level, which is 4 ft. 6 in. above the ground. These pens are three deep on north and south of shearing board, the two outside storage pens being 10 ft. by 10 ft., and through these the sheep pass to the catching pens, which are 10 ft. by 9 ft. After being shorn, the sheep are passed down a ramp opposite each shearer to the counting pens, which are post and rail enclosures under the general floor, extending out into the open to south and north.

From the cross section through shearing board and pens (Plate XXV.) it will be seen how these arrangements are planned. This section shows the shearing board, with a high roof over and ridge ventilation. The lighting is over the back of catching pens, and is so fixed as to give good diffused light direct to the place where the shearers work. Two shearers use the one catching pen, which is on the general level, a counting pen below being reserved for each man. The section shows these rail-enclosed pens, which are all fitted with gates. The pens are covered with a low lean-to roof, and are lighted and ventilated by a continuous row of louvred openings, extending along the entire south and east sides of building. At the western ends windows are arranged, so that sheep may be driven towards the light when coming in from the eastern doors. This is a point to remember, for sheep go more readily to the light when entering a building.

The wool room is directly open to the shearing board, with the floor upon the same level. This is a large, open apartment, 70 ft. by 40 ft., with 15 ft. inside walls and open timber, king post roof.

For constructional purposes the roof is divided into six cross spaces, and five roof principals carry the continuous purlins for the roof iron. Between the principals the side windows and doors are arranged. The windows at the side are kept specially high up and

shaded by wide overhanging eaves supported on brackets. Ventilation is carried on by a ventilating turret.

This wool room is fitted with the furnishings and apparatus required for the general work of dealing with the fleece and wool after it comes from the sheep. There are, first of all, the wool tables, nearest to the shearing board, upon which the wool is first deposited, and next the classers' table, on which the quality of the wool is determined before it is passed to the bins. The bins are next to the press, and the weighing machine is placed handy to the clear end of the room from which the bales are passed out through the dray doors.

All timber in or near the ground should be red gum, the stumps being protected with sheet-iron ant stops. All general structural timbers are of hardwood, with Oregon tie beams for the roof. The floors of all storage and catching pens within the building are laid with open battening, cut arris wise, so that the droppings may pass through. The floor of shearing board and wool room are laid with Queensland hoop pine.

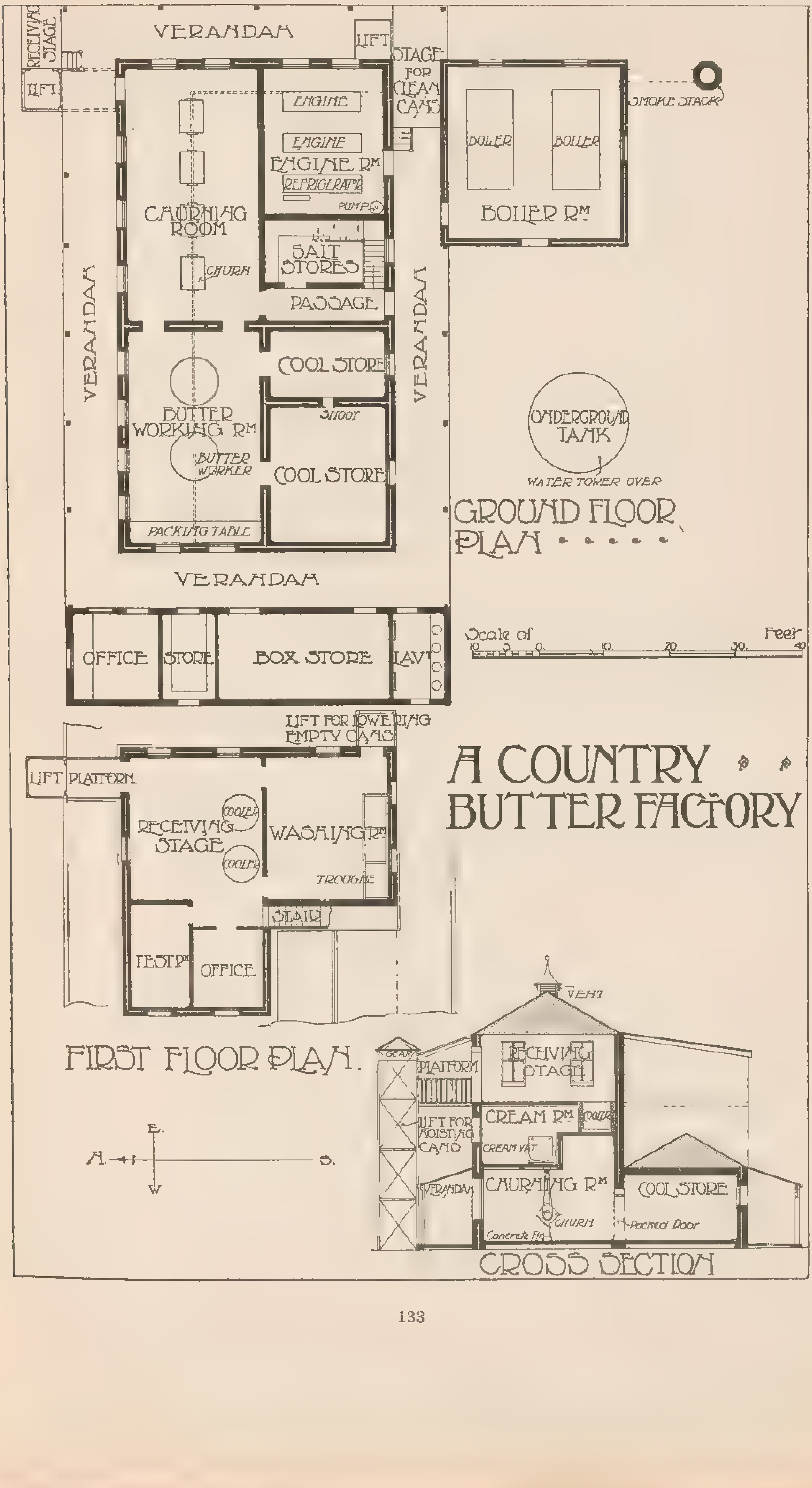
The whole of the external surfaces of the walls and roof are covered with galvanized corrugated iron, painted with cooling composition.

BUTTER FACTORIES.

As one of the staple industries of Australia is butter-making, there is an increasing demand for buildings suitable for this purpose. These differ with the locality, and also with the class of building material most readily available.

For this type of planning a thorough knowledge of the scientific treatment of milk and cream for butter-making purposes, and its preparation for home and export consumption, is essential, coupled with skill in arranging the machinery and plant to the best possible advantage.

The main object of design should be to properly house the plant.


RECEIVING STAGE
LIFT
VERANDAH
LIFT
STAGE FOR CLEAN CANS
ENGINE
ENGINE
ENGINE Rm
REFRIGERATR
PUMP
CHURNING ROOM
CHURN
SALT STORES
PASSAGE
BOILER
BOILER
BOILER Rm
SMOKE STACK
VERANDAH
VERANDAH
COOL STORE
SHOOT
BUTTER WORKING Rm
BUTTER WORKER
COOL STORE
UNDERGROUND TANK
WATER TOWER OVER
PACKING TABLE
GROUND FLOOR PLAN
VERANDAH
OFFICE
STORE
BOX STORE
LAVy
Scale of Feet
10 5 0 10 20 30 40
LIFT FOR LOWERING EMPTY CANS
LIFT PLATFORM
COOLER
RECEIVING STAGE
COOLER
WASHING Rm
TROUGHS
STAIR
TEST Rm
OFFICE
A COUNTRY BUTTER FACTORY
FIRST FLOOR PLAN.
N.
E.
S.
W
VENT
GEAR
PLATFORM
RECEIVING STAGE
LIFT FOR HOISTING CANS
CREAM Rm
COOLER
CREAM VAT
VERANDAH
CHURNING Rm
CHURN
COOL STORE
Packed Door
Concrete Flr
CROSS SECTION

This should be the very first consideration, and everything should start from this objective.

To decide, therefore, upon the necessary machinery and plant is of primary importance, and must be considered side by side with the site, character of climate, and orientation of the building.

The whole process of butter-making should be so carried on as to ensure the most thorough cleanliness. Every part of the building and plant should be so arranged as to be easily washable and rendered impervious to the lodgment of injurious bacilli.

In buildings of this class the different constitutions of factories should be borne in mind. Some take milk only, some both milk and cream, others again cream only. This last type of factory is quickly becoming the most common, owing to the great advantages obtained from the system of home separating.

Plate XXVI. shows a factory where cream only is treated. This is necessarily different in area and construction from one where milk or both cream and milk are dealt with, as, in the latter types, larger floor spacing and slightly different arrangements have to be made.

Economy and cleanliness in handling is of the first importance, and this necessitates, in the first instance, easy and convenient approach for the suppliers, and the prevention as far as possible of dust from cartage, and its entrance into the building. All outside walls and the roof are best well insulated, so as to ensure evenness of inside temperature. A full and constant supply of pure, cool water is also absolutely essential to the working of all butter factories, and should be made available to all convenient points. The floor in churning, butter-working, and washing-up rooms should be of smooth material, as far as possible without joints, and graded to open channels with direct leads to a proper system of outside drainage.

Plate XXVI. illustrates a butter factory working four churns and two butter-workers. The walls are of brick, built hollow, all internal surfaces being hand-trowelled in cement, and all angles

rounded. The cream, in cans, is received from the supply vehicles at the N.E. corner of the building, and elevated, by means of a lift, to the receiving stage, where it is graded, and samples taken for testing. The cream is then passed through the coolers into the cream vats, of which there are three upon a sub-floor below (see cross section). These vats are placed immediately above the churns, and from them the cream passes directly into the churns below. The subsequent processes are allowed for upon the ground floor (see plate). Here the churning room is shown, a butter-working room, two cool stores, salt store, &c.

Allowance is made for washing the cans upon the first floor in the washing room, which has a reinforced concrete floor with special finish to withstand the wear and tear of the cans. The cans are then passed down a light lift to a clean can stage placed at cart height above the ground floor, where they may be readily passed out to the suppliers' return vehicles.

The other points of the design are made plain by the drawings. The building is shown with brick walls and reinforced concrete floors, the cool store being carefully insulated.

Power is provided, and space allowed for plant in boiler and engine houses, the boilers being kept carefully away, so as not to overheat the building.

STABLES.

Many regulations that apply to house-building have equal reference to the planning of stable buildings. The site should be dry, and as in this class of building there is special need for the floors to be practically upon ground level, the general site should be, if possible, slightly elevated from the surrounding land, and all drainage and water supply should be carefully regulated.

Aspect, too, has much important bearing upon stable planning, especially with regard to hot or cold prevailing winds and sunshine.

Stable buildings are of varying character, according to the class of stock served.

There is the racing stable, in which the most valuable stock is housed, requiring in every part high-class fittings and arrangements; the private stable, often of well nigh equal importance, but needing arrangements for vehicle housing and other accessories not found in the racing stable; and, thirdly, the large class of buildings for all round work of coaching, livery, station, and farm use.

This question of stable-planning is a large one, and calls for much variation of arrangement according to circumstances. A few guiding rules, which apply more or less to all proper stable-building may, however, be here laid down.

Planning. In speaking of stable-planning, it should be pointed out that the beginning of stable-planning is with the stalls or loose boxes—the one or the other, or both. Stalls should be about 6 feet wide, with about 9 feet 6 inches of length from head wall to heel post, with a passage way, in the case of a single row of stalls, of about 7 ft., which may well be increased if stalls be numerous or in double rows. About 140 ft. super. is a reasonable area for a loose box nearly or quite square.

Vehicle houses should be planned of sizes to suit each vehicle, with easy access and ample height, and, for the sake of the paint, away from the stable fumes.

Harness is best kept out of a stable and in a proper harness room.

Feed storage will call for greatly varying conditions of planning, some owners requiring large storage areas and others but small spacing. These conditions will soon be felt in the plan, as also space required for grooms or attendants, and whether quarters be required for married men or not.

Adequate arrangements should be placed in the plan for paved washing yards, both for horses and vehicles; means for obtaining hot water is also often desirable, where the stable is away from the

house service, while the position of the manure pit, storage for tools, and approach for feed delivery should all be thought of.

With the actual requirements in each case enumerated, harmony of grouping is of the first importance, and as the idea of a stable is "shelter," this idea of shelter should be well before the mind in the planning, for this reason. All the working parts are best in some measure roofed over and doors screened from heavy winds.

The height of a stable over stalls or loose boxes need not, for all general purposes, exceed 11 ft.

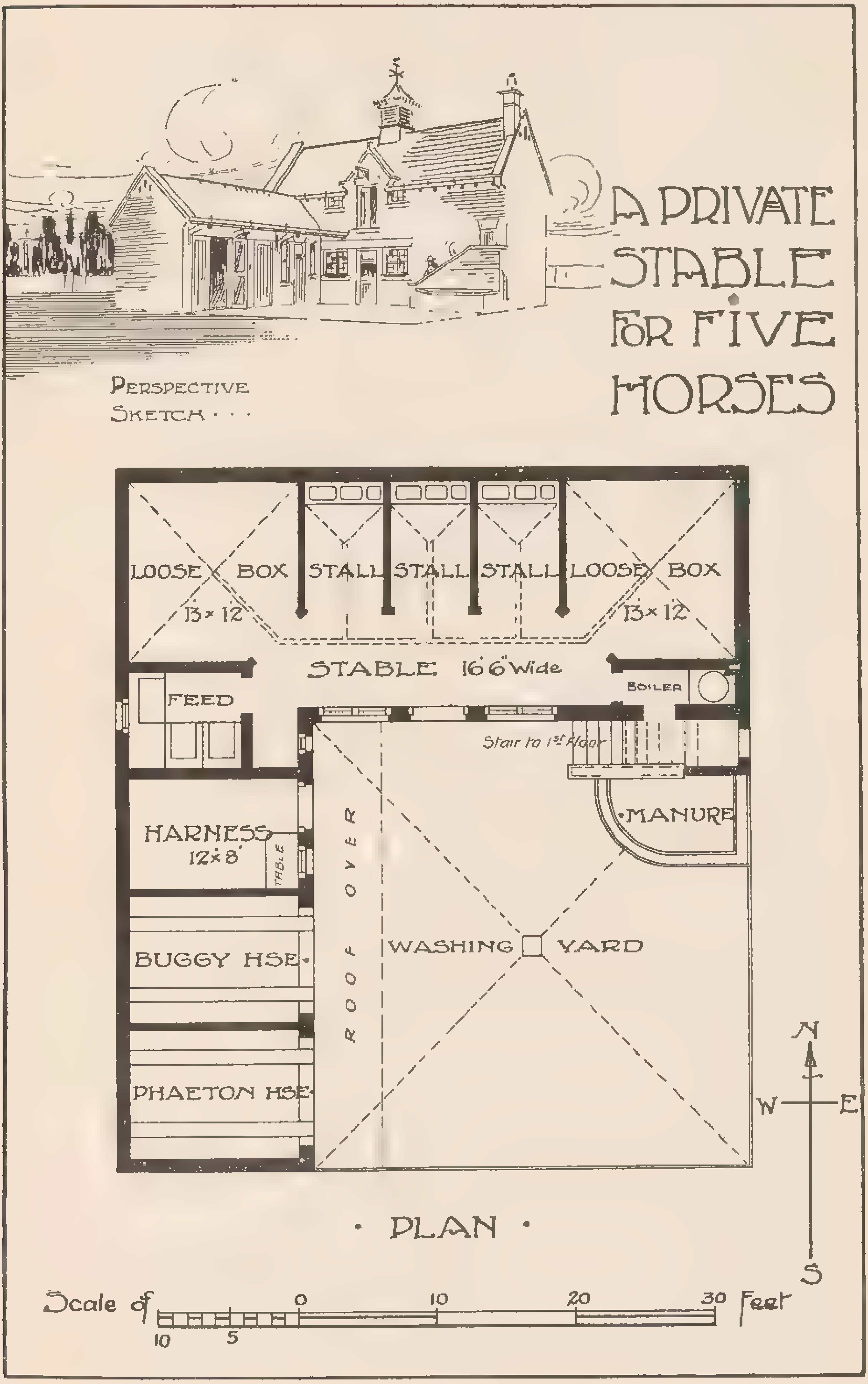
CONSTRUCTION. The rules that apply to all good sound building apply equally to stable-building. If of wood the structure should be well braced, the weatherboards close fitting, and all timber in the ground, or liable to constant saturation, should be of jarrah or red gum. For this reason wood block or slab floors, or any floors other than those of impervious hard bricks, are open to serious objection.

If an iron roof be used, a loft will offer valuable interposition between the changes of temperature and the stable proper.

The best class of stables are built of hollow brick walls and tiled roofing.

The aim of the best stable construction should be to create "impervious internal surfaces" in all the working parts, both walls and floors, and also yards, that may be hosed out and kept sweet and clean.

Windows.—Stable windows should be kept high up and well out of the way of the work. They are best small and in small panes of glass. The pivot-hung sash has much to recommend it, as it allows the whole of the opening to be exposed to air currents. Hopper-hung sashes are also good, and double-hung sashes offer better service than the casement for this class of work. To protect the windows with permanent Venetian shuttering is often desirable, so that the stable may have the light shut out when the heat and glare of summer and the pest of flies become acute.


A PRIVATE
STABLE
FOR FIVE
HORSES
PERSPECTIVE
SKETCH · · ·
LOOSE BOX
13 × 12
STALL
STALL
STALL
LOOSE BOX
13 × 12
STABLE 16' 6" Wide
FEED
BOILER
Stair to 1st Floor
MANURE
HARNESS
12 × 8'
TABLE
ROOF OVER
WASHING YARD
BUGGY HSE
PHAETON HSE
N
W
E
S
· PLAN ·
Scale of
10
5
0
10
20
30
Feet

Doors.—The sheathed door or flush outside panelled door is best for stables. For vehicle houses and for stables other than those where loose boxes open directly out to the open air, the sliding door is best if good, practical, easy-working gear be adopted. This form of hanging has the great advantage that the door may be opened little or much without slamming—an important consideration in a stable door.

Paving.—All ground floor surfaces are best laid to falls with impervious material. For horse wear a surface is needed that is at once hard, durable, and non-slippery, and for this purpose specially made, hard, grooved stable bricks are best, laid on concrete and grouted in cement. For general purposes specially hard burnt ordinary bricks, if set on edge, make a good lasting floor.

Partitions.—Where a large number of horses have to be stalled together, a space-saving division may be made with the bale pole (a suspended piece of heavy timber between the stalls, about 14 in. by 2 in. by 8 ft. long). For all general purposes the permanent division is best constructed of wrought iron and wood or wood only.

To each stall a strong, stout heel post should be well buried in the ground, and the partition formed from post to wall, starting at about 4 ft. 6 in. next to the post, and rising to 7 ft. in height next to the wall.

About 7 ft. is an average height for loose box partitions, the upper 2 ft. 6 in., of which is much improved if arranged with vertical iron grilling in place of close boarding.

This also applies to stall partitions.

Mangers.—Mangers should be set to a height of about 43 in. to the top of the nosing; those of enamelled iron are best. If wood be used the front nosing is best carefully sheathed with galvanized sheet iron.

Feed Bins.—Feed bins, if of wood, should be lined with galvanized sheet iron or zinc, and have close-fitting hinged lids to keep out vermin. They may be made of such sizes as to act as measures, with a gauge scale painted upon the inside.

Drainage.—If a stable be away from a sewerage system, a well-graded scheme of clean, open drainage is best for all purposes.

Where a stable is within a sewered area the local regulations will govern the drainage.

Ventilation.—Ample currents of pure air are highly desirable in the stable, and these should be secured both night and day. Inlets may be arranged through windows, or through walls by upcasting hoppers, and exhaust shafts may, with advantage, be carried right through the roof to flèche or exhaust cowls.

Plate XXVII. shows the plan of a private stable, with three stalls and two loose boxes.

The aspect is south, which protects the stable door and working parts of the plan from hot north winds and dust, while, for harnessing up, the buggy-houses are sheltered from the south-west rains.

The stable itself is a rectangular apartment, 44 ft. long by 16 ft. 6 in. wide by 11 ft. high, containing two fairly large loose boxes, 13 ft. by 12 ft., and three stalls between. The light is mostly from the south, but small, high, hopper-hung lights are provided in north wall for winter use.

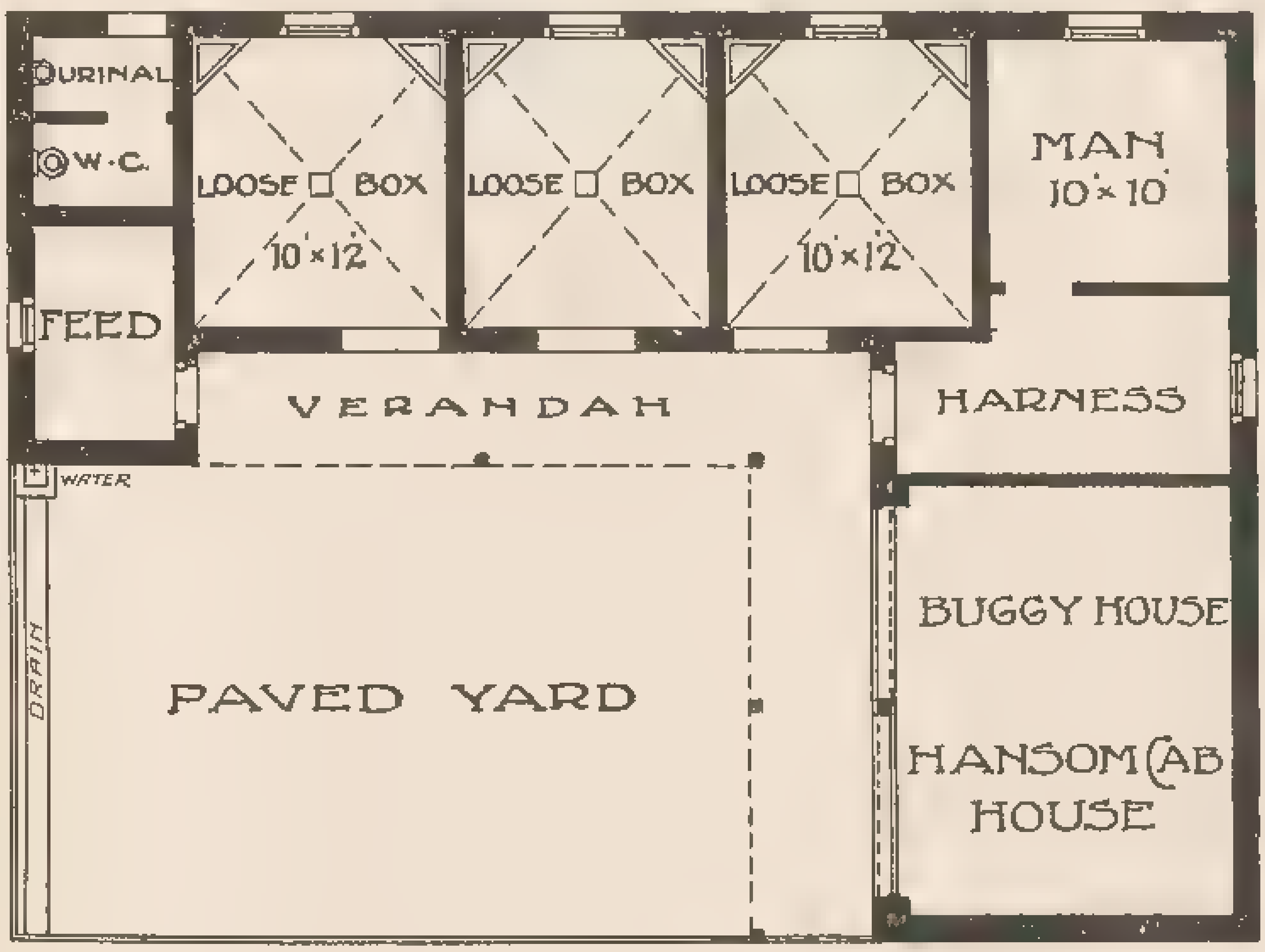
The feed-room opens directly off the stable, and is fitted with bins filled from the loft above by means of galvanized-iron hoppers and tubes. There is a space near by for forks, rakes, and stable tools. At the east end of the stable is a boiler house for hot water, with a fuel store under the stair, served with a pitching door from east side. The saddle and harness room is 12 ft. by 8 ft., with east light.

The two buggy-houses are planned for full-sized vehicles, and have floor runners for wheels. All along in front of these apartments there is a verandah roof for harnessing up under shelter in bad weather.

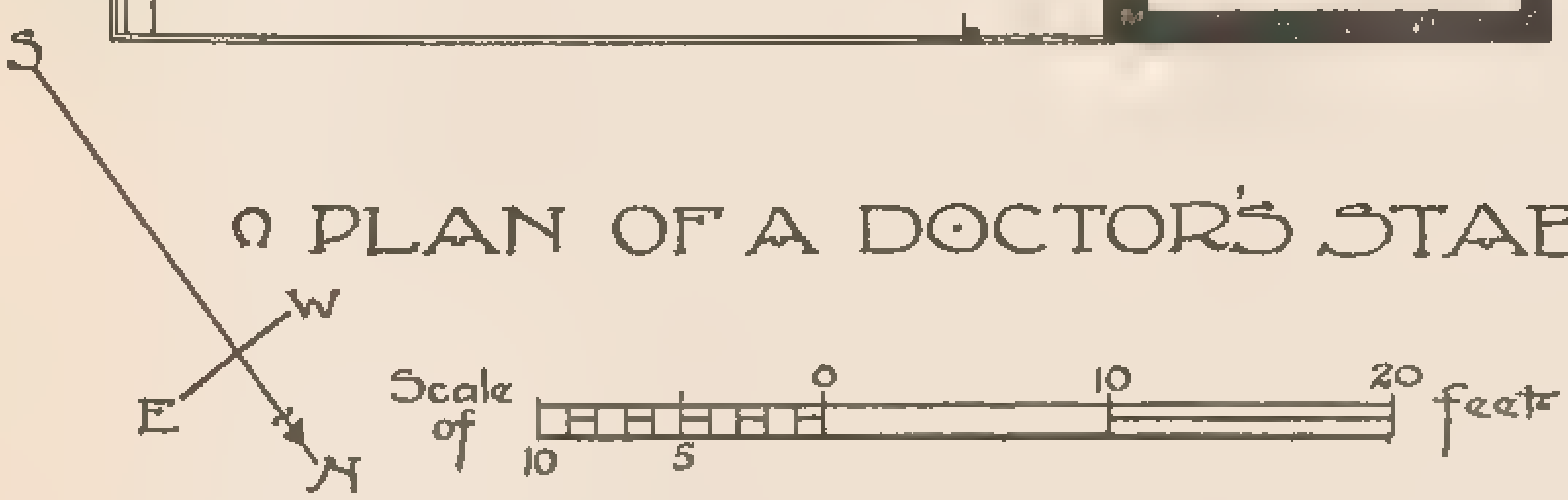
The stable proper has a loft over, served by a stone stair to a small passage, with a man's room facing east and a storage loft over the remaining portion, fitted with outside loft doors and

PERSPECTIVE SKETCH

A ONE-STORY SUBURBAN STABLE BUILDING



PLAN OF A DOCTOR'S STABLE



hauling tackle. The walls are of brickwork, built hollow, with ground floors of specially hard burnt bricks set on edge to falls. The roof is tiled, and there is a special outlet ventilating shaft from the stable ceiling to the flèche above roof.

Plate XXVIII. is a plan of a one-story doctor's stable in a suburban area, where small feed storage only is required, and where drainage is connected with underground sewers. There are three medium-sized loose boxes, 12 ft. by 10 ft., with doors opening north-east direct on to a verandah, and the doors, being in two leaves, give the animals a chance of direct outlook, which secures an arrangement preferred by some proprietors.

The vehicle house is specially deep, so as to take a hansom cab, a vehicle that requires some full 14 ft. of length, as, unlike other light vehicles, the shafts in this vehicle are rigid and not hinged. Good height is also arranged to take the 8 ft. 6 in. over all measurement of cab. The doors of the vehicle house are arranged on overhead rollers, and run one in front of the other.

The harness-room is directly off the verandah, and is well lighted.

The feed-room is at the opposite end.

A verandah is arranged to connect up all the working parts of the building, and the plan as a whole gives good opportunity for through ventilation and perflation.

Racing Stables.—A racing stable, requiring, as it does, different accommodation from an ordinary stable, has to be so planned as to suit this special kind of horse housing.

Such a stable is generally a unit in a group of detached buildings, comprising the trainer's residence, a barrack building for apprentices, a small ordinary stable building, and the racing stable.

The plan here given (Plate XXIX.) embraces the general requirements of a racing stable.

The aspect is east, and the main entry through a pair of

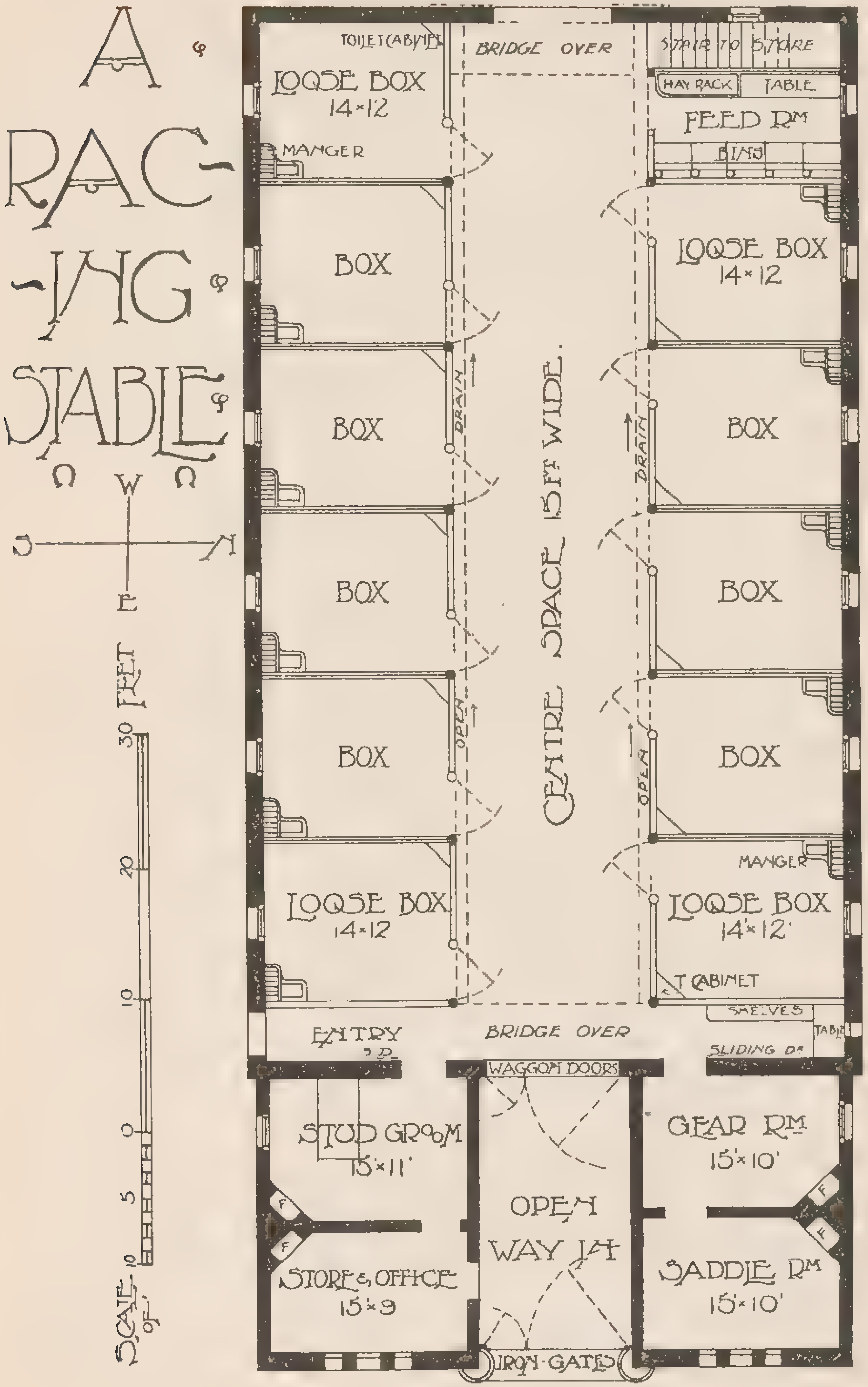
iron gates—one wide for special use, one narrow to act as wicket for everyday use. These gates lead into an open way (not roofed over). To the left is a store and office under the direct control of the stud groom or foreman in charge of the stable, who has a room opening off this, where he may sleep, and be in direct touch with the stable proper through the sliding door shown. To the right two other rooms are grouped, approached direct from the stable—first, the gear room, where rugs, cloths, and gear of all kind are stored; and next, the saddle room. These rooms are fitted with cases, wardrobes, lockers, &c.

The stable proper is purposely kept apart from these working apartments. It contains eleven loose boxes, each 14 ft. by 12 ft., with a 15 ft. wide central approach way, with wide waggon doors at western end.

Each loose box is a complete room in itself, 12 ft. to ceiling, with 8 ft. high enclosures, the outer partitions of which are close boarded, and the divisions between the boxes similar up to a height of 5 ft., and for the remaining 3 ft. enclosed with round iron bar railings. This is so arranged that the horses can see each other, yet be undisturbed by what is passing in the central space.

The manger and hay racks, of enamelled iron, are placed in one corner of each box. Water receptacles are not provided, as differences of opinion exist as to the wisdom of allowing a horse unlimited water supply. Another corner is occupied with the toilet cabinet.

The box doors are 4 ft. wide in two tier leaves, so that the lower half may be closed, and the upper portion left open, should the horse require special watching by the attendant, who may, by this means, look in when engaged about the general work of the stable. These doors are also planned directly in front of the manger, so that, when the horse is feeding, an attendant entering the box may naturally approach the horse on the near side—*i.e.*, the left side of the animal—an important item in door-planning.


A RAC-ING STABLE
W
S
N
E
SCALE OF FEET
0 5 10 10 20 30
TOILET CABINET
BRIDGE OVER
STAIR TO STORE
HAY RACK
TABLE
FEED RM
BINS
LOOSE BOX 14×12
MANGER
BOX
BOX
BOX
BOX
LOOSE BOX 14×12
DRAIN
OPEN
CENTRE SPACE 15 FT. WIDE.
LOOSE BOX 14×12
BOX
BOX
BOX
MANGER
LOOSE BOX 14'×12'
T CABINET
SHELVES
TABLE
ENTRY
BRIDGE OVER
SLIDING DR
WAGGON DOORS
STUD GROOM 15×11'
F
F
STORE & OFFICE 15×9
OPEN WAY 14
GEAR RM 15×10'
F
F
SADDLE RM 15×10'
IRON GATES

It may be here mentioned that doors are best hung opening out, or sliding from outside. Otherwise, should an animal (as often happens) become "cast" in the box, he may lie in such a position as to obstruct the opening of the door, and thus prevent its use in an emergency.

Light and ventilation is obtained through shallow, high-up windows, fitted to open inwards as hoppers, with close cheeks to prevent down draughts.

The general finish consists of wrought-iron uprights supporting the roof at the ends of box divisions, iron gate posts, and grooved iron frame fitted with 4 in. by $1\frac{1}{2}$ in., T. and G., and V-jointed, fair both sides, upright lining, oiled. The wall surfaces to a height of 8 ft. are lined with brown glazed bricks, the floor being of grooved vitrified stable bricks.

It should be noted that the whole of the drainage of this stable is carried out by two simple open channels outside the boxes, one on each side of the centre space, with an outlet at the western end. This leaves the building entirely free from underground drains of any kind. In stables where valuable stock is kept, and where the attendance is very constant, some owners prefer this system, as the actual flow into a loose box drain is very slight when bedding is constantly down, and the underground drains, if not carefully attended to and periodically flushed, may give rise to fevers and other disorders among the animals.

At the north-west corner of the ground floor a feed room is placed, with conveniences for dealing with the daily feed work. Zinc-lined storage bins with tube corn shoots are arranged here, as also large hay-rack, &c. These are replenished directly from above.

In section the building is arranged as follows:—The four rooms at the east front are ceiled at a height of 11 ft. and roofed over with gable-ended roofs. The main building is ceiled at a height of 12 ft. over loose boxes with a hardwood ceiling to match the box divisions. Above this a long storage loft some 6 ft. high runs

right along the top of the whole range of boxes, from end to end, on both sides. The centre space is carried up and ceiled at a height of 25 ft. from the ground floor, and is lighted and ventilated by alternate windows and louvres on either side overlooking the lean-to roofs that cover the loft space over the boxes.

In racing stables the bulk storage of feed and bedding has to be provided for. In this case the wide doors at either end allow of the in and out-going of waggons with hay or other feed, and its uplift on to bridges at either end of stable, and thence to lofts at the sides.

As only old oats may be used, which should be stored for some years, provision is made for storing in bulk by the reservation of a close room, where the grain is unbagged and space allowed for turning it over from time to time, to assist the maturity of the grain. In this way it is also kept free from vermin, who work less readily in loose corn than in the bagged material.

As an adjunct to the stable a brick-paved washing floor is provided, with provision for hosing and watering. A space is also given up to a sand bath.

The apprentices are housed in a detached building, consisting of a general barrack sleeping room, fitted with bunks, and with a diningroom attached for general use.

HOSPITALS.

Hospitals and Asylums Generally.—Among modern buildings hospital planning occupies an important place, as, with advancing civilization and the progress of medical science, each year brings forward new demands for increased and improved accommodation among our hospitals and charitable institutions.

Such buildings require to be designed, in many ways, as a class by themselves, bearing in mind the various subdivisions of the subject, which require in some degree separate consideration, notably where asylums and charitable institutions are erected, not

necessarily classable as hospitals, but having rather the character of associated residences, closely allied to hospitals for the sick.

Site and Area.—In considering hospital planning in general the question of "site" and "area" is in the highest degree important, and those considerations which govern healthy building, which we have before enumerated, must here have added consideration. Not only should the site be in a suitable and healthy locality, but it requires to be ample for the number of patients proposed to be accommodated upon it. For this purpose, to allow an acre for every 20 patients if infectious, and 80 patients per acre if non-infectious, is a reasonable working basis.

General Design of Hospitals.—For outlying country districts a small hospital is usually sufficient, such as is shown in Plate XXXI. This class of country cottage hospital is usually administered by a local medical man, a superintendent's and nurses' residence being in close proximity. Providing the apartment spacing is good, the sanitary offices disconnected, and the operating room well isolated, such a plan provides a practical building for ordinary requirements. In large general hospital planning, however, the invariable practice is now adopted of separately grouping the various types of accommodation in distinct buildings, with inter-communication by means of covered ways only.

These buildings consist usually of a centrally placed administrative block, containing all the necessary apartments required for the due working of the institution. The wards are contained in separate pavilions, with the sanitary offices to each again isolated from the wards themselves by being placed in a disconnected annexe, and such other separated buildings as kitchens, medical officers' residences, nurses' quarters, &c., engine house, mortuary, and the numerous other buildings required in a fully-equipped institution. The spacing in the wards may be divided into three

classes—infectious, non-infectious, and surgical—and should be allowed for somewhat in the following ratio :—

	Infectious.	General.	Surgical.
Cubical contents ..	1,500 ..	1,200 ..	1.000 cube ft.
Floor space	120 ..	100 ..	84 super ft.
Bed intervals	7 ..	5 ..	4 lineal ft.

A window should be provided on both sides of every bed, and a ward should not be less than 12 ft. high or 100 ft. long, with every angle in the interior rounded, and all surfaces impervious and washable.

If erected with timber a hospital should never exceed one story in height. When of other material, all construction should, as far as practicable, be fire-proof, especially if the building is several stories in height, and ample means of escape by fire-proof stairs should be provided, there being two ways out from each ward or block, with special fire hydrants, hoses, and other fire-extinguishing apparatus ready to hand in case of emergency.

Elevators are best placed in an annexe. All stairs should be fire-proof, and doors and means of communication should be wide, ample, and well lighted, both by night and day. For natural lighting of wards, one-fifth to one-sixth of the super. area of the wards may be taken as a guide for window area.

Ventilation should be very ample, both through windows and also by means of artificial inlets and outlets, and both warming and cooling of incoming air might well be considered, and special provision made, not only for a complete system of hot and cold water installation, but for the carrying away by drainage of all wastes, and the destruction by fire of all solid refuse.

These points, together with the proper orientation of the wards, the division of the sexes and classes of patients, convenience of communication, both internally and externally, and ample outdoor sheltered areas, such as paved courts, verandahs, or balconies, and the all-important value of easy administrative working, should all be remembered in hospital planning.

PLATE XXX.

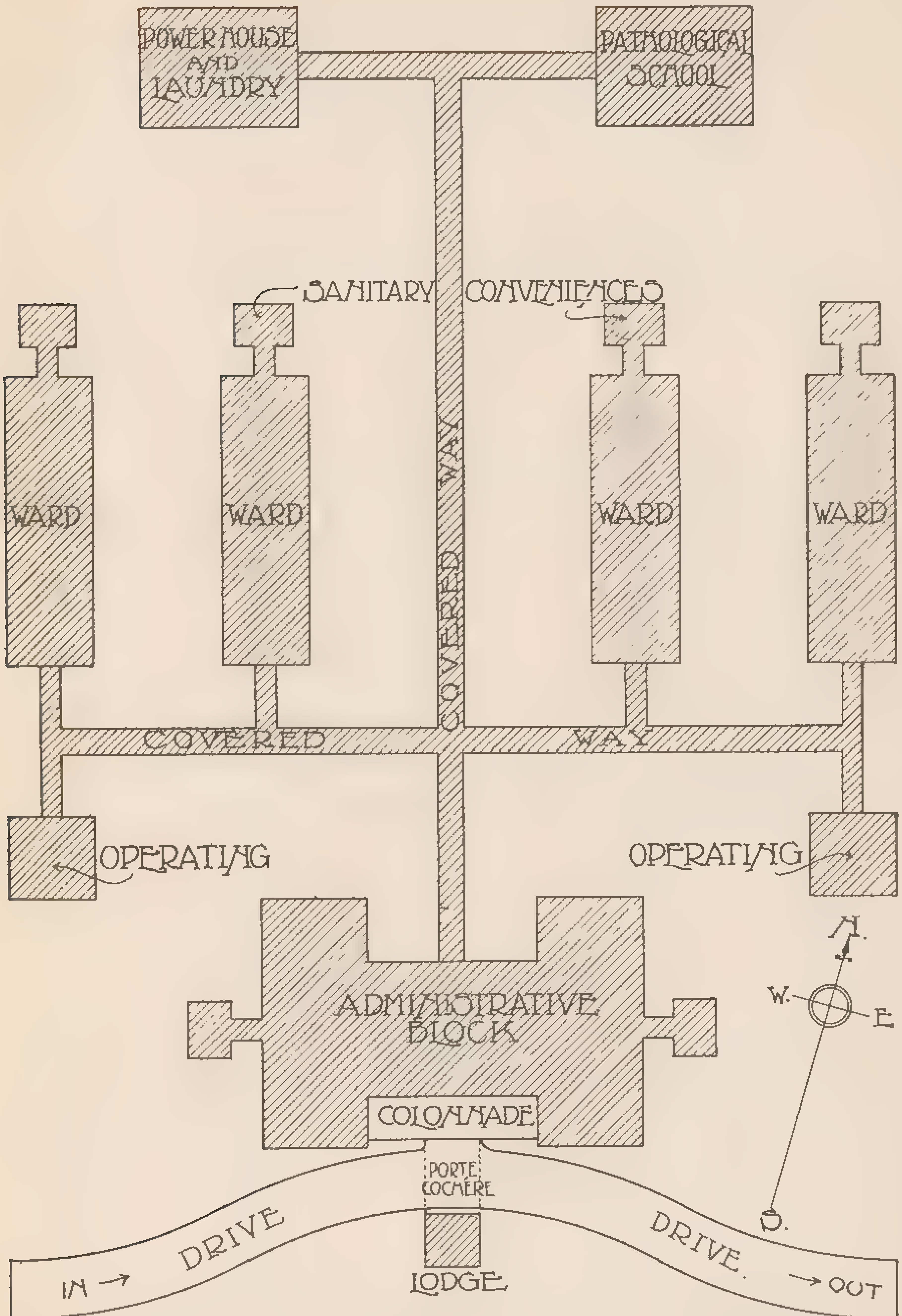


DIAGRAM ILLUSTRATING THE GENERAL PRINCIPLE OF HOSPITAL PLANNING.

Principle of General Planning.—Plate XXX. illustrates broadly the general principle usually adopted in large hospital planning. The figure shows the general road approach to the administrative block which, in this case, faces south and has a "porte cochere" and porter's lodge at entrance. The porte cochere is roofed overhead, so that, in wet or stormy weather, persons passing from or into vehicles may do so under cover, the lodge-keepers being at hand night and day to overlook arrivals and departures.

The administrative block communicates by covered ways with the four ward blocks, called "pavilions." These may be one or many storied, and are orientated side on to east and west, to obtain full sun-lighting. The west sides might with advantage be protected from too excessive heat by verandahs, and the east by outside Venetian shutters.

Beyond the pavilions and to the north-west is the power-house for hot water, electric energy, or lighting apparatus, &c. To the east of this a pathological school, or other necessary buildings of the same character, could be placed.

The ward pavilion, in a plan of this character, may be extended to east and west as required, or a small isolation ward could be placed to the south of it upon the other side of the covered ways.

The space between the pavilions should be such that the sunlight, in some part of the day, reaches the whole of the walls, unaffected by shadow from adjoining buildings.

This diagram is given merely as illustrating a principle, not necessarily as an actual instance to be followed, for it will be found in practice that every scheme of planning must of necessity show variation of requirement and treatment.

Cottage Hospitals.—The building shown on Plate XXXI. is a cottage hospital only, and illustrates a type of semi-private hospital suited to country districts where such an establishment is administered by one or more medical practitioners.

The plan shows four wards, three being for two patients each,

while a fourth is for one patient only. These wards have generous super. area, and face east or west, with windows on each side of beds. A bathroom fitted with a wheel bath and a linen store are convenient to the wards. The hot western and northern sides of the plan are protected by a wide verandah. There is an 8-ft. wide entry, with a sitting room for convalescents or visitors opening off it. The kitchen offices and store are grouped together so as to allow no odor of cooking to enter the main portion of the building.

It should be noted that the operating room is disconnected from the main building, and is arranged with a south (neutral) light, partly vertical and partly as a roof light. This apartment is reached through wide pair doors, and has a fireplace, sinks, &c., and a sterilizing apparatus. The walls, flooring, and ceilings here require to be absolutely impervious and washable.

At the extreme north end of the plan, reached by a covered way, the wash-house and sanitary offices are grouped, so as to be within reasonable touch of the working of the establishment, yet cut off from actual contact. These consist of the usual laundry equipment, together with large sinks, slop hoppers, W.C's., and an isolated chamber for the reception of ward wastes.

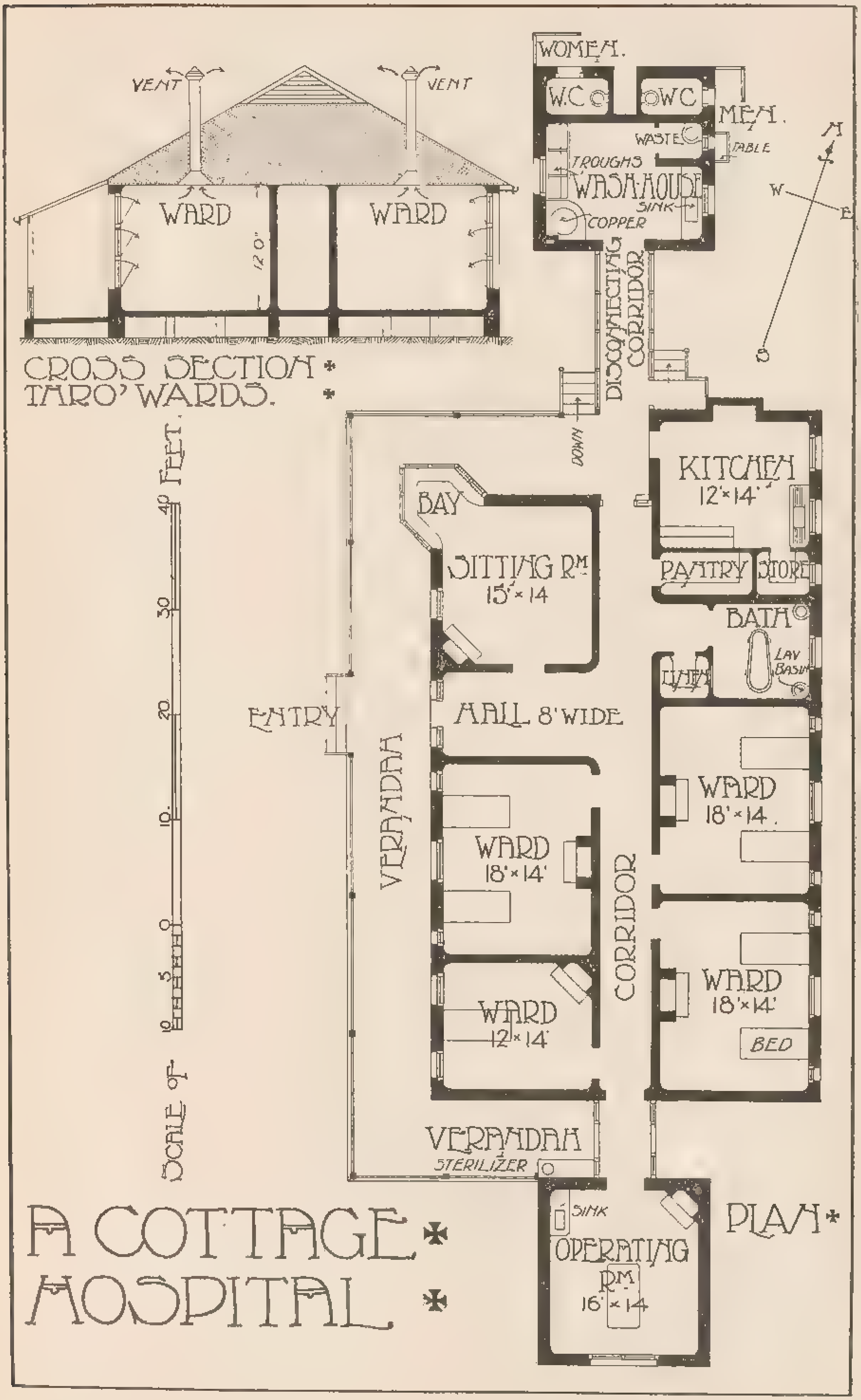
The main building has a height of 12 ft. from floor to ceiling, the windows being hopper-shaped to open inwards in three heights, with 2 ft. from the floor to the lower edge of the glass and top hopper well up to the ceiling.

The roofs of such a building require to be well insulated, and the walls, if of brick, hollow, so as to maintain, as far as possible, equable temperature within.

Ventilation should be carried on, as described in "Ventilation," by special inlets, and tube ceiling outlets through the roof, the roof being ventilated separately.

CHURCHES.

Introductory.—In church planning we have a class of building in many ways distinct from all other types, and needing, in con-


VENT
VENT
WARD
WARD
12'0"
CROSS SECTION THRO' WARDS.
SCALE OF FEET.
0 5 10 0 10 20 30 40
WOMEN.
W.C
WC
MEN.
WASTE
TABLE
TROUGHS
WASH-HOUSE
SINK
COPPER
DISCONNECTING CORRIDOR
DOWN
N
W
E
S
KITCHEN 12'×14'
PANTRY
STORE
BATH
LAV BASIN
LINEN
BAY
SITTING RM 15'×14
ENTRY
HALL 8' WIDE
VERANDAH
WARD 18'×14'
WARD 12'×14'
CORRIDOR
WARD 18'×14.
WARD 18'×14'
BED
VERANDAH
STERILIZER
SINK
OPERATING RM. 16'×14
PLAN
A COTTAGE HOSPITAL

sequence, that separation of treatment away, somewhat, on the one hand from the domestic, and removed, on the other hand, from the mark of pure commercialism.

To design a church as it should be designed requires, in a measure, special gifts, and certainly success in this may not be obtained without strong sympathy, in the designer, towards those meditative and religious sentiments which create around such buildings so much of their true charm and atmosphere.

Not Commercial.—Few things are more fatal to success in church design than to introduce, in any way, the spirit and detail of commercial buildings, for one is entirely foreign to the other, and should be kept so in treatment; yet this warning is not without need, as we may see by even a casual study of the subject, and the inspection of some of the buildings around us.

We may also hope to see, as our architectural knowledge increases, less of the "dog kennel" type of church building, and more regard given towards the obtaining of a pleasing mass, even in the simplest types.

The first object of a church building is, and rightly so, utilitarian. It should be built to accommodate a certain number of people in comfort, with adequate seating, lighting, pure air, space, and means for the proper performance of the prescribed ritual, with safe in and out-goings and approaches; but while doing all this full remembrance should be given to create and conserve some spirit both of tradition and meditation.

Church designing gives specially rich opportunity of subject whereon to play for composition. All religion is in some measure historical, and in its progress and growth has held sacred certain symbols and emblems, as well as dress and ritual, and these have gathered round certain types of building and methods of construction, and have in no small measure influenced both their planning and their ornamentation, so that, for whatever sect a church may be planned, the designer should have these traditions before his mind, and so blend the old with the new,

the utilitarian with the sentimental, and the whole so conforming with local climate and needs as to best conserve some happy balance of the whole.

Seating Accommodation.—Wherever, as is very often the case, the old Gothic church plans are repeated in our own day, we are at once confronted with the fact that, whereas the old churches were designed for assemblage and ambulation, the modern church is only required for seating accommodation. Where procession was the order the side aisles with their columned arcades added mystery to the ceremonial, but, when this feature is repeated in modern work, it immediately offers difficulty where the audience should in all parts of the building be able readily both to see and hear the preacher.

Character of Design.—In a country such as Australia, where national church establishment does not exist, and where all religious sects have equal rights before the law, the domination of the building of one denomination has not to be so largely considered as in the lands where the Established Church has for centuries had the wealth and prestige of national support.

Here, with a well-nigh virgin field, each denomination may seek to build as it will, and to lay down in a new country new traditions, and, with many, these traditions have already been built into a number of the fine churches that Australia owns.

We cannot, however, help the conviction that progress may be made upon the lines of designing more for our own climate and national conditions than has heretofore been the general rule. An architecture, distinctly truthful and happy in its harmony with a cold, wet climate, can hardly be transplanted to the sunny skies of temperate conditions without undergoing considerable change to make its application at all pleasing, if such a transplanting is really, when naturally considered, the right thing to be recommended at all.

All true art has sprung, like nature's trees, from place and special local circumstances, and so to Australia's actual conditions

may we not, in our church designing, in more earnest measure bend our powers.

Super. Area of Plan.—The first consideration in church planning is one of superficial area, and practice will show that, taking a normal case, about 4 ft. super. may be allowed per person for actual seating, and about 7 ft. super. for the whole auditorium, including aisles, &c. Having fixed this and added fair accommodation for choir, vestries, &c., we find that, exclusive of land, a plain, soundly-built brick church can generally be built for about £8 per sitting—a price that will greatly vary if wood be used or if stone be substituted, as also if towers or spires be adopted.

Having determined the broad super. area, the question of orientation must be settled, and where ritual (as it often does) requires the altar to the east, this will greatly influence the placing of the plan upon the site.

The question, too, of direct sun during service times must be carefully considered, side by side with the approaches.

The "seat" regulates everything in the church, and its size, number, and position should be laid down in the very early stages of the planning.

Fix the length of seat—not too many sittings in a row; for instance, not more than five from each aisle.

Fix the seat grouping with easy approaches, from aisles and exits, to doors.

Draw a line from each and every sitting to the preacher and the ritual points, and be assured that every sitter may see and hear.

Allow for a slightly sloping floor, which has now been fully established as one of the most necessary devices for the comfort of those who use modern churches.

For churches such as the Anglican and the Roman Catholic allow extra width in seating to permit of sitter finding space for kneeling. This will, of course, modify the whole super. area of the building.

Table. of Sizes.—The following table may be found useful in

general church planning. The dimensions given are normal, and are subject to variation, according to circumstances :—

Accommodation, Including Aisles, &c.

For every person	*7 ft. to 8 ft. super.
Ditto, seating space only	*4 ft. to 5 ft. super.
Width of seats back to back ..	*32 in. to 36 in.
Length of seat for each person ..	*21 in. to 24 in.
Height of seat from floor	*17 in. to 18 in.
Width of seat	*13 in. to 15 in.
Height of seat backs	*33½ in. to 35 in.
Book boards, height from floor ..	*29 in. to 31 in.
Book boards, width..	4 in. to *5 in.

Dimensions marked thus * are recommended.

Equipment.—Apart from the church itself as a structure, the equipment and furnishing of the building should find harmony of design, the one with the other, for which we may here lay down a few practical hints.

In deciding the timber to be used in seating, pulpit (if of wood), and furniture, it is best to adopt the same kind of timber as used in the internal doors, so that all woodwork within the range of the eye towards the floor of the building may be alike.

General Seating.—For seating, the best is Australian wood, undoubtedly—dry, well-figured blackwood, dull French polished—but this is expensive. For all general purposes New Zealand kauri offers one of the very best woods at medium cost, either stained and varnished, or left plain and varnished, or dull French polished.

In deciding upon the design of the seat, it has to be noted that church seating is required to suit the average sitter—men, women, and children; the dish of the seat, the angle of the back, whether cushions are to be placed upon the seat or not, whether open or closed backed, height of bookboard, and the ease of ingoing into seat at ends, and space for the passage of persons within the seating, are all points of vital import, and some experimenting with model pieces, roughly knocked up, and of

the actual size, is the best way to arrive at a practical conclusion before the whole seating is ordered.

Choir Seating.—Choir seating may be somewhat further elaborated from general seating, for which ample precedent is found in the old world churches, but care should be taken to avoid the unhappy appearance of high bookboards, and consideration should be given to the appearance of the choir when seated. These high bookboards, at times, are so set as to come directly in front of the face of the sitter, and look very inharmonious when the choir is placed facing the audience.

The Pulpit.—Next to the seating, the pulpit is the most important, for all eyes turn in this direction. Its position, its height, and its size should all be carefully weighed in relation to the seating, so that everyone, with ease, may both see and hear the preacher, and that the eye may find pleasing rest upon the pulpit itself, as well as that the structure should offer full convenience for the occupier.

The size of the pulpit is a matter mostly of ministerial taste, but an octagonal pulpit of about 5 ft. 9 in. diameter is, for a pulpit, fairly spacious, with handrail 30 in. high, and bookboard with normal height of 39 in. A pulpit should have a comfortable seat or bench, a glass holder for water, watch holder, and small shelves under the bookboard for papers. It should also be specially well lighted. The approach should be easy, while some approachment space between the incoming door from the vestry and the pulpit itself is best arranged so as to offer easy and graceful access.

The Rostrum or Platform.—Where a rostrum is planned in preference to a pulpit, while carrying out generally the above rules, greater expanse of superficial area will be required. A rostrum, too, offers more opportunity for open work treatment, where good wrought iron and metal work may often be introduced.

The Sanctuary or Chancel.—In the sanctuary and the chancel all

equipment must needs conform specially to the ritual of the church, and, providing it be designed in character with the building and in the same style as other equipment, save that it may be some degrees richer, the result should be harmonious.

Entries.—In entrance lobbies and entries specially designed equipment should be made, such as settles or chairs, book cabinets, and tables, framed plan of church seating, and, if gas or electric light be used, these things are best administered from such places, where attendants have easy access and control to taps or main switches. The boot scraper and the sunk mat should also be included, and in country churches hat and coat hooks and umbrella stands may also with advantage be added.

Vestries.—Vestries and retiring rooms should all be equipped with furniture of an ecclesiastical character, and for these apartments the rush-seated plain church chairs, on the English model, look well, and may be manufactured in Australia with local-grown rush and frames of Australian wood.

Stores.—Stores should not be overlooked. In all churches there is need for cupboards and properly planned places where various things may be put away and locked up, and these should be provided and become part of the general arrangement of the building.

The choir vestry, for instance, should have book and music cabinets fitted with pigeon-holed subdivisions, while stewards' cupboards and cupboards for caretaker's gear should also be thought of.

Illustrations. — Plates XXXII. and XXXIII. show an Anglican church with 464 general sittings and 36 choir sittings.

The plan (Plate XXXII.) is so arranged as to suit the ritual of the Church of England, by the grouping of a spacious chancel to the east of the nave and somewhat raised therefrom. This chancel contains the choir benches, which occupy the north and south walls, with the pulpit at the north-west corner and the reading-desk at the

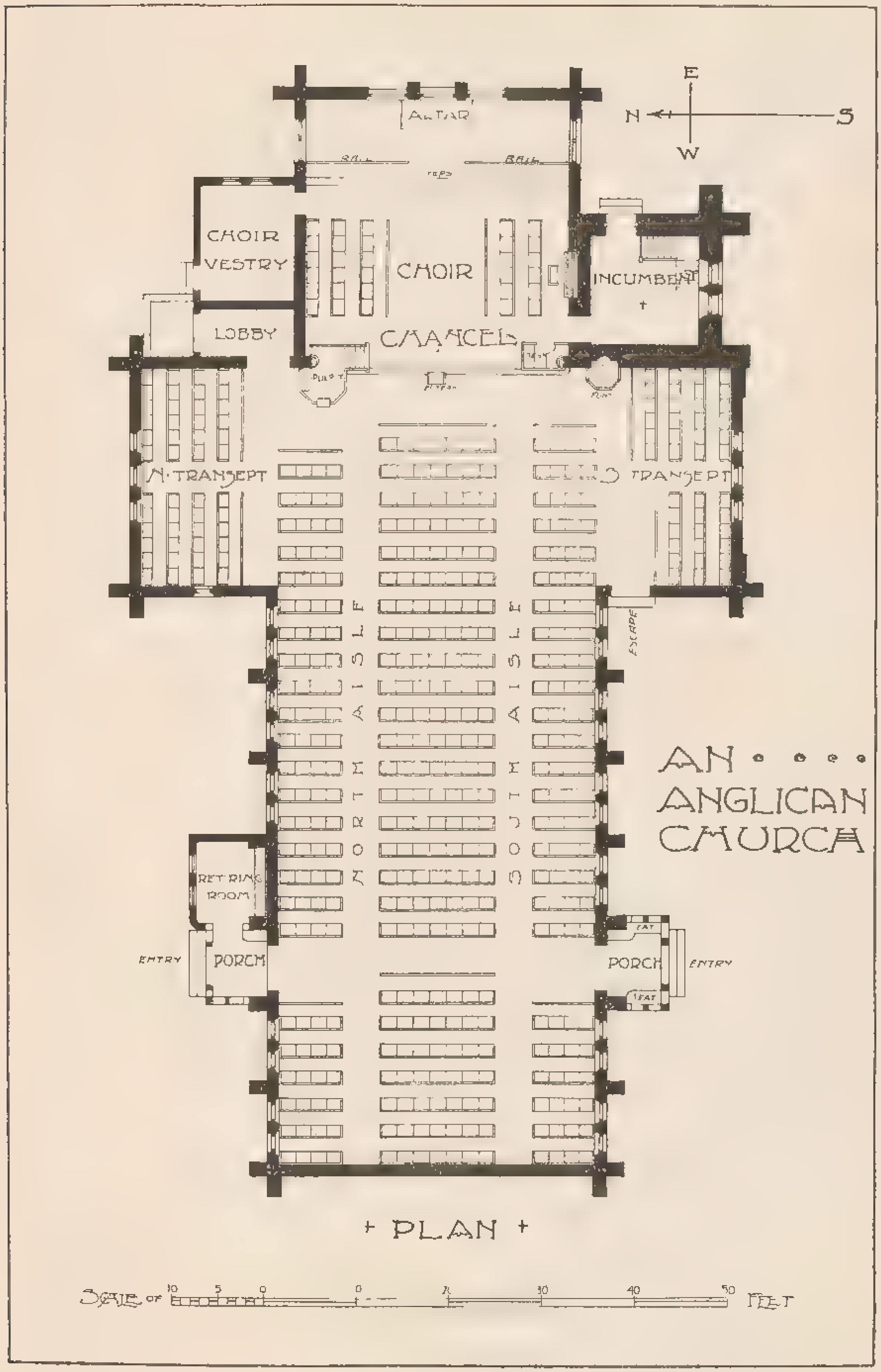

AN ANGLICAN CHURCH
E
N
S
W
ALTAR
RAIL
RAIL
CHOIR VESTRY
CHOIR
INCUMBENT
LOBBY
CHANCEL
N·TRANSEPT
S TRANSEPT
ESCAPE
NORTH AISLE
SOUTH AISLE
RETIRING ROOM
ENTRY
PORCH
PORCH
ENTRY
SEAT
SEAT
+ PLAN +
SCALE OF FEET
10 5 0 10 20 30 40 50

PLATE XXXIII.

†† AN ANGLICAN CHURCH †† View from the S·E ††

south-west corner. The communion is again raised from chancel, and has railed-off separation.

The incumbent's vestry has a direct approach from the outside and a door into the chancel at the end of the choir.

The choir vestry is at the S.E. corner of the building, and occupies the lower portion of the spire, the belfry and bells being above, the total height of the spire being 95 ft.

The length of the nave is 88 ft., with a width of 35 ft., with 4 ft. aisles.

The transepts are 24 ft. wide by 15 ft. deep, the chancel with the communion being 29 ft. wide and 28 ft. deep.

The height of the walls inside from the normal floor level is 18 ft., with 37 ft. as a full total height of open roof.

The general structure is of brick, with stone dressings and slate roof constructed inside with open timbering.

Plates XXXIV. and XXXV. show a design for a Presbyterian church with 502 general sittings and 43 choir sittings.

The general form of auditorium is arranged in a rectangular form, north to south, with very shallow transepts, the choir being slightly raised on a platform immediately in front of the congregation, with a pipe organ at the back, manipulated by means of an extended manual keyboard.

In front of the choir there is a slightly raised dais, upon which chairs and movable communion table are placed. This space, in the case of a Baptist Church, could be used for the pool below.

The general approach is through two front wing lobbies, served by flights of steps that lead to the highest level of the auditorium floor, which has a slope of some 3 ft. 6 in. to the north end. Two other doors, mainly for escape, give access from the transepts.

The choir enters through a door near the back on the western side, and files up a small flight of stairs into the choir seating.

A small minister's vestry is provided, with approach to pulpit made direct by small door in north wall of auditorium, leading, by

short way, to pulpit steps. The north-east corner is occupied by a vestry for small meetings.

The style of the design is Gothic, carried out mainly in plain red brickwork, the windows being executed in hand-curved tracery in freestone, with roof covering of green Vermont slates.

The interior is treated with open timber roof, lined with hand-dressed red Californian pine, dull oiled, and with roof principals showing, being ceiled at the collar, at height of 32 ft. from lowest point of floor, the height of internal walls from same point being 20 ft.

The great front window, 20 ft. wide, is only made possible by reason of its position due south, as in this way it does not receive any direct sunlight, and is made to form a valuable feature from the interior, where the stained glass shows to great advantage.

The ventilation is arranged by a complete service of hinged hopper inlets through the lower portion of the windows, the outlets being in ceiling perforations, connected by close iron tubes with ridge vents.

Plate XXXVI. is for a Roman Catholic Church with 115 sittings. The choir is accommodated in a gallery at the western end, approached by a stair in S.W. corner, and has seating room for 20. The area of the body of the church is 40 ft. by 32 ft., with a sanctuary occupying 15 ft. by 14 ft., with a 12 ft. by 10 ft. vestry.

The main entry is by a bold western porch, with wing doors, an escape being provided at the end of the south wall.

This church is treated in a simple Romanesque manner, with 16 ft. internal walls and open timber roof rising to 25 ft., the sanctuary walls being about 13 ft. 6 in. and the vestry 10 ft. 6 in. inside.

Plate XXXVII. shows plans of three small churches, suitable for nonconformist worship in country districts.

Fig. 1 shows a plan without sanctuary, a preacher's rostrum, choir and communion platform being substituted. This building contains 183 sittings, with seats for 20 in the choir. The main approach is planned to suit a corner site, and leads up a flight of

PLATE XXXIV.

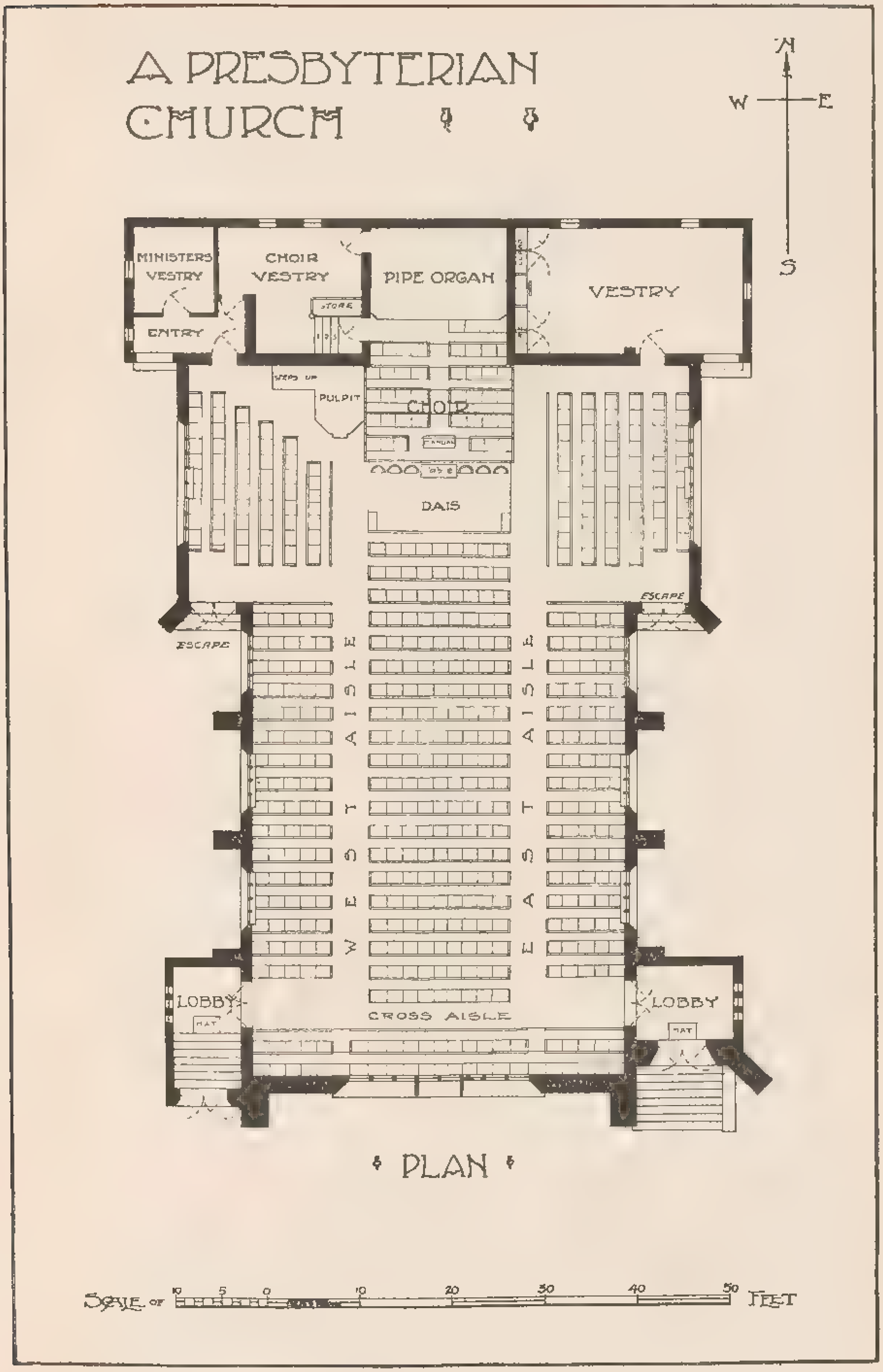
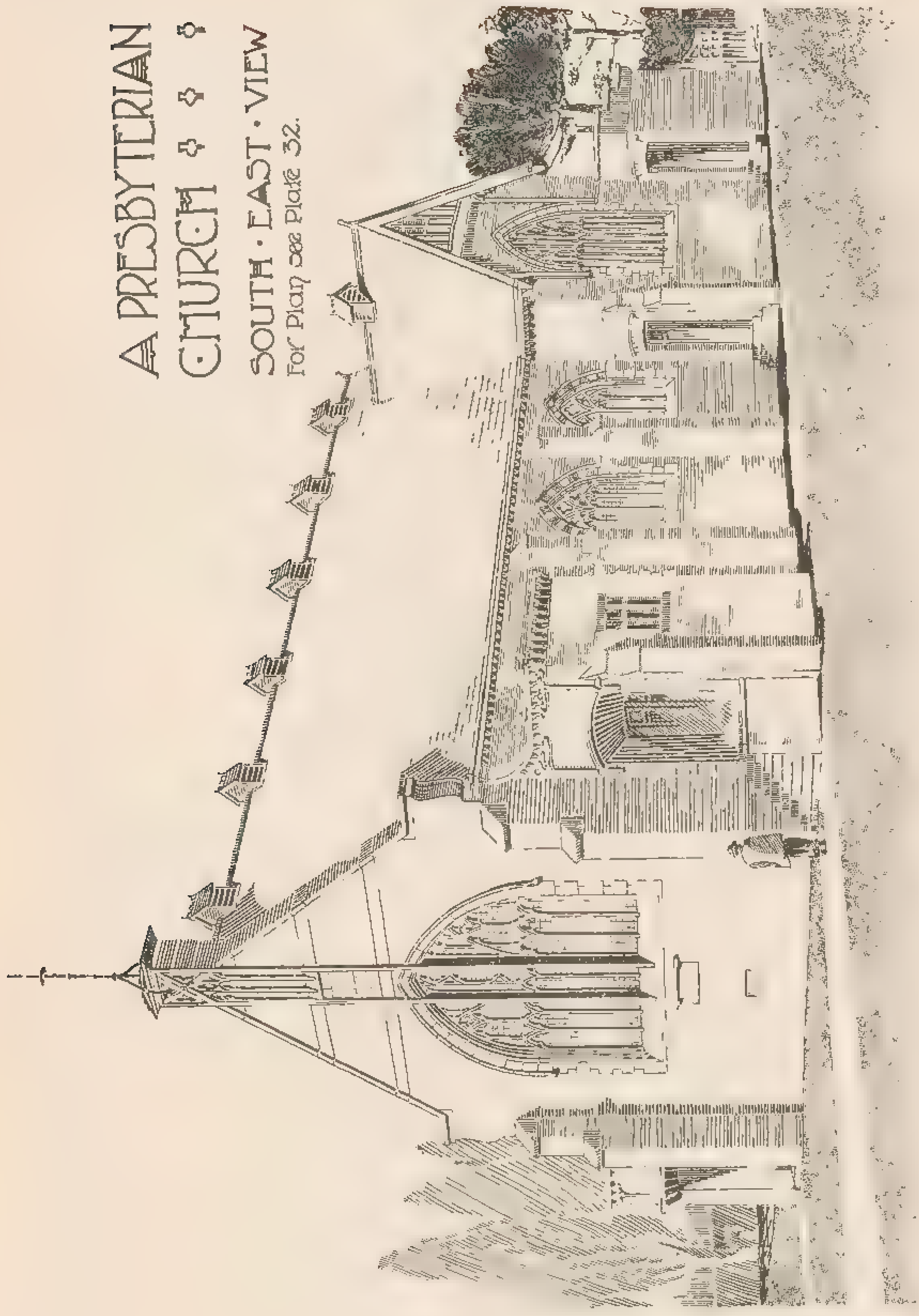

A PRESBYTERIAN CHURCH
N
W
E
S
MINISTERS VESTRY
CHOIR VESTRY
PIPE ORGAN
VESTRY
STORE
ENTRY
STEPS UP
PULPIT
CHOIR
DAIS
ESCAPE
ESCAPE
WEST AISLE
EAST AISLE
LOBBY
LOBBY
MAT
MAT
CROSS AISLE
PLAN
SCALE OF 10 5 0 10 20 30 40 50 FEET

PLATE XXXV.




A SMALL CATHOLIC CHURCH + +
PLAN
SANCTUARY
VESTRY
NAVE
PORCH
STAIR
Scale of
30 feet

steps to a roomy lobby, which screens the internal doors from cold prevailing winds, and also offers good space for the administration. There is a 14 ft. by 11 ft. minister's vestry at S.W. corner, and escape doors and screening lobby at N.W.

This building would be best with a floor showing 2 ft. slope, walls 20 ft. high inside from lowest level of floor, and roof at angle of 50°, the main inside dimensions being 56 ft. by 34 ft.

Fig. 2 shows another type of plan. This is upon the theatre principle, with an auditorium 50 ft. wide and 40 ft. deep, having seating for 183 persons and 20 in choir. The general seating is grouped around three sides, each row of seats being raised up 5 in. above those in front.

This is a type of plan sometimes preferred before a rectangular grouping, especially where the width of land is ample, and a compact grouping around the preacher is specially desired.

In this case the ministers' vestry and choir vestry group upon the north wall, coupled with the N.W. escape door.

The front has a wide break, with a large south window, flanked on either side with the entrance doors.

In a general style of treatment this would be best designed for a Romanesque finish, with a flat ceiling and low-pitched roof with wide overhanging eaves.

Fig. 3 is a plan forming a simple rectangular interior with two aisles, the seating accommodation being for 281 persons, with 23 in the choir. The main approach is through a centrally-placed doorway into a long entrance lobby, a minister's and choir vestry being placed at the back of the plan.

The interior of the church is arranged in five bays, with buttressed walls and windows designed for treatment in the Gothic manner.

Plates XXXVIII. and XXXIX. show plans and perspective respectively of a nonconformist church carried out in a modern adaptation of the English-Gothic style.

Here the plan (Plate XXXVIII.) is arranged as a large open area, with transepts, central pulpit spacing, and choir in the south

transept. Some elaboration of work and largeness of spacing is shown at the main entries, a large vestibule and N.W. tower being planned.

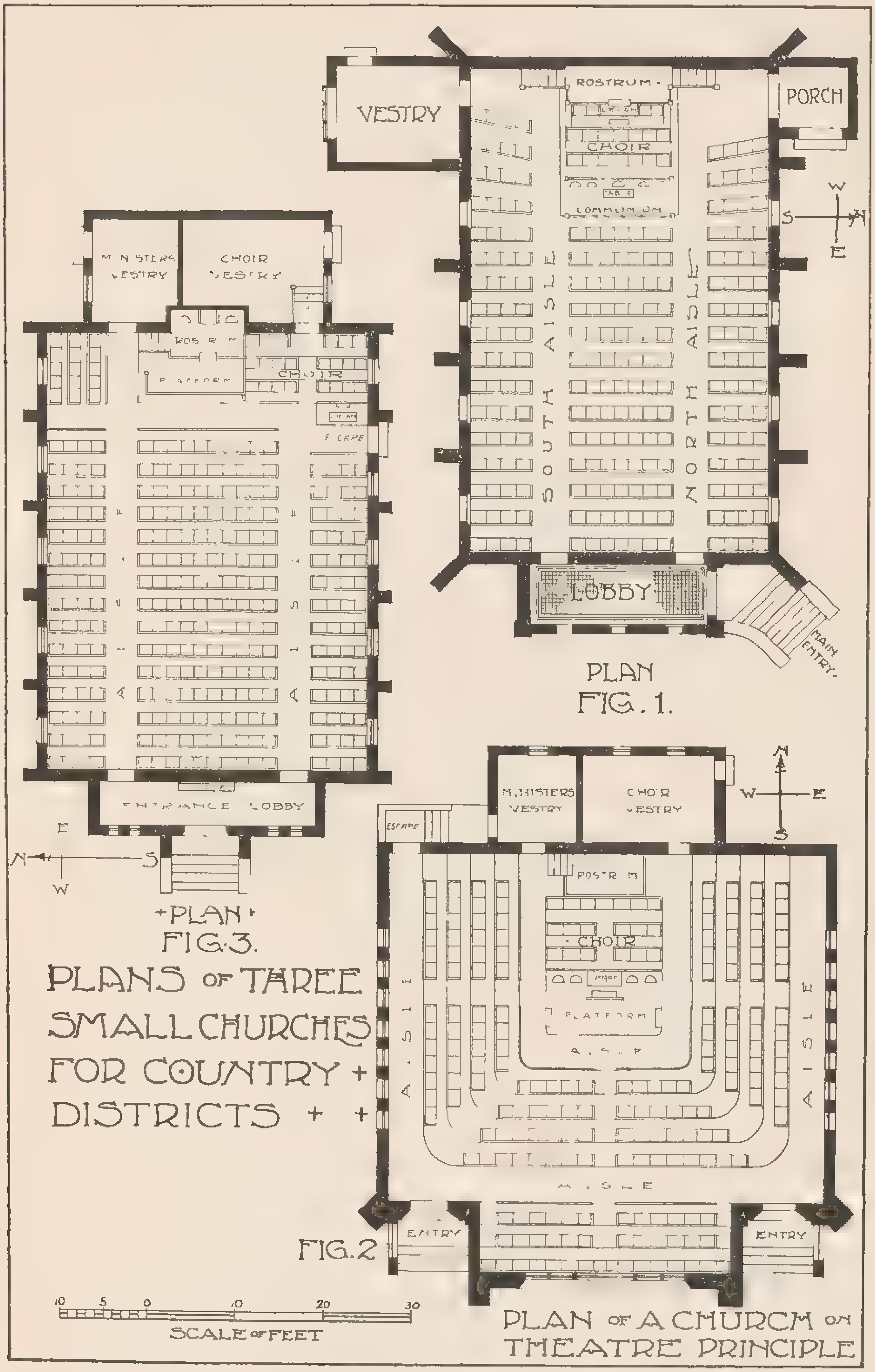
The seating, including choir, is for 545 persons, the elevational treatment being shown in the perspective drawing (Plate XXXIX.)

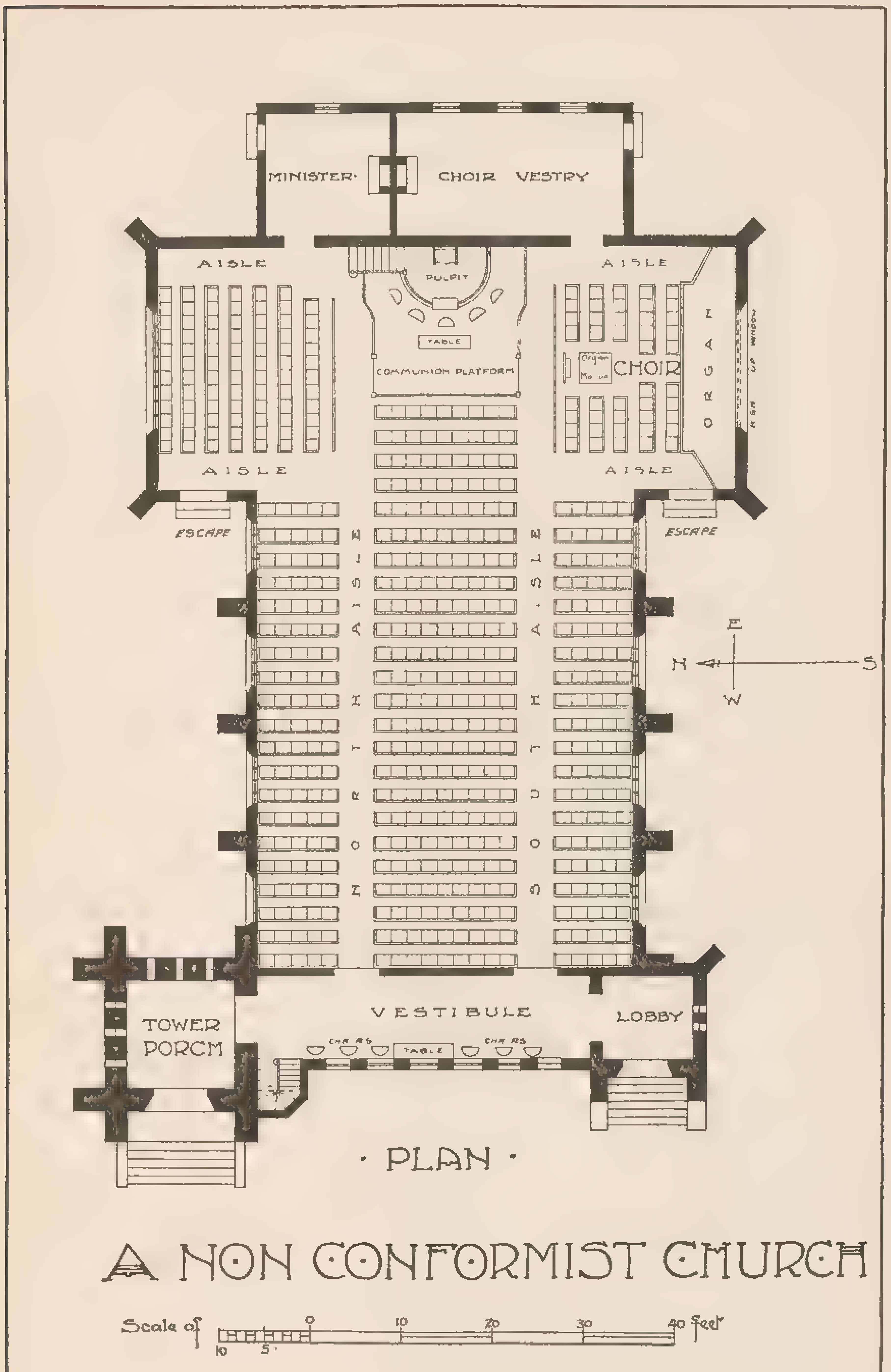
To maintain the public safety, church buildings should be designed distinctly as public buildings, and it is only right that certain laws should be enacted for the enforcement of certain fixed requirements.

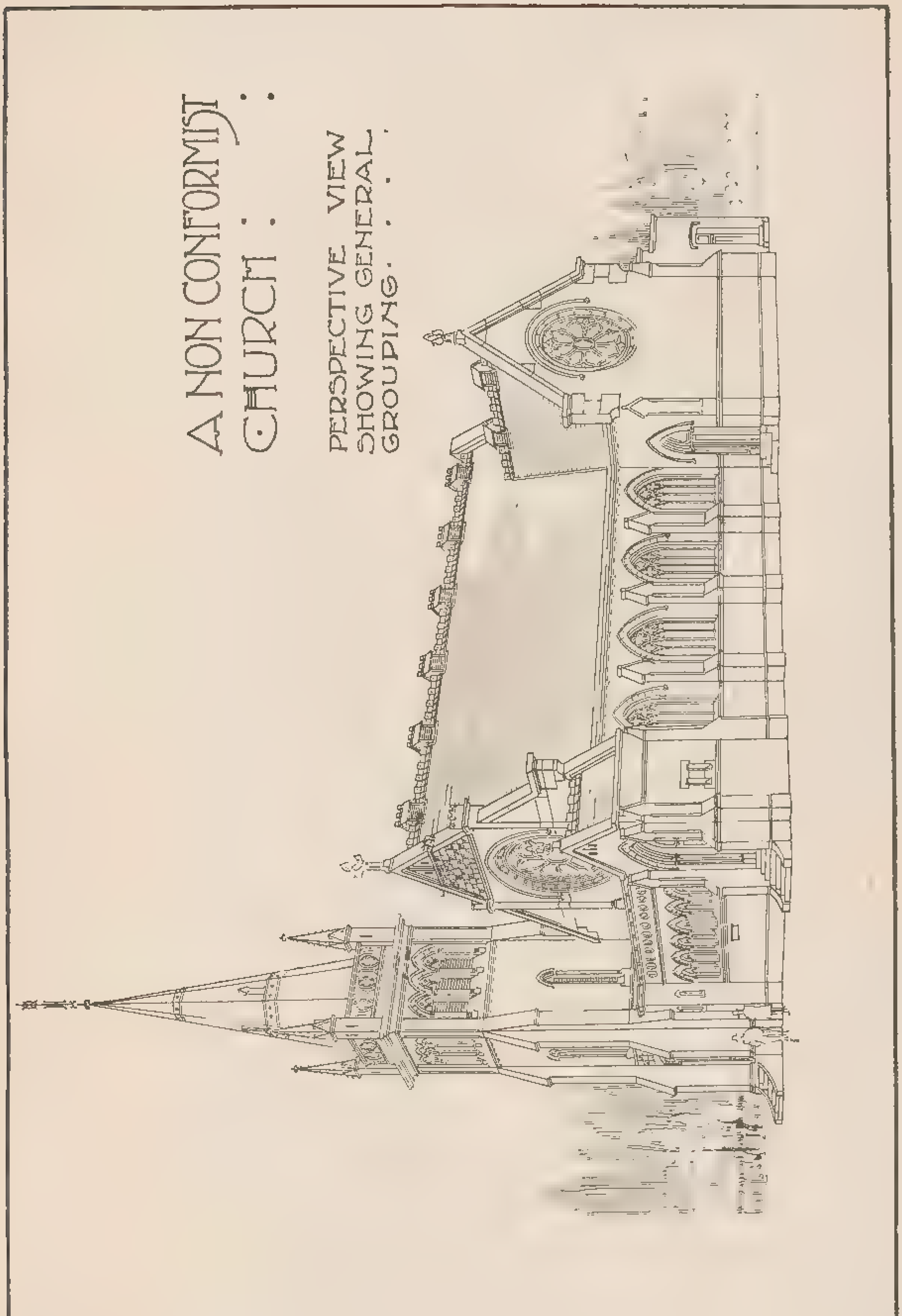
In some parts of Australia, under the *Health Acts*, the opening of any church for public worship is forbidden without the written consent of the public authorities, and certain requirements are in force which have to be complied with in the work.

On the whole these requirements have tended towards decided improvement in church planning, and, although upon first consideration some of the requirements appear vexatious to the designer, yet in actual practice they, on the whole, work out well when properly applied, and tend to safer and more hygienic buildings than were heretofore erected.

These requirements have to do chiefly with exits, width of aisles, doors and fastenings, fire appliances, ventilation, and ease of outgoing in case of fire.


VESTRY
ROSTRUM
CHOIR
PORCH
SOUTH AISLE
NORTH AISLE
LOBBY
MAIN ENTRY
W
S
N
E
PLAN
FIG. 1.
CHOIR VESTRY
ENTRANCE LOBBY
+PLAN+
FIG.3.
PLANS OF THREE SMALL CHURCHES FOR COUNTRY + DISTRICTS + +
M. NISTERS VESTRY
CHOIR VESTRY
ESCAPE
CHOIR
PLATFORM
AISLE
ENTRY
ENTRY
FIG.2
10 5 0 10 20 30
SCALE OF FEET
PLAN OF A CHURCH ON THEATRE PRINCIPLE


MINISTER
CHOIR VESTRY
AISLE
AISLE
PULPIT
TABLE
COMMUNION PLATFORM
CHOIR
ORGAN
AISLE
AISLE
ESCAPE
ESCAPE
NORTH AISLE
SOUTH AISLE
E
N
S
W
VESTIBULE
LOBBY
TOWER PORCH
CHAIRS
TABLE
CHAIRS
· PLAN ·
A NON CONFORMIST CHURCH
Scale of
10
5
0
10
20
30
40 feet


A NON CONFORMIST
CHURCH : :
PERSPECTIVE VIEW
SHOWING GENERAL
GROUPING . . .

CHAPTER VIII.

FURNISHING.

It may be taken as a safe policy of modern practice that the designer of the building should also be the designer of the furnishings.

The design of the house and the character of its furniture are so inseparably intermixed and interdependent that success in the one can hardly be established without the close co-operation of the other, and doubly so when it is remembered how largely permanent fittings of various kinds now form an actual constructive part of modern buildings, and go so far towards their equipment.

This strong tendency in the best modern work to bring the one more closely into harmony with the other is to be emulated, for it is based upon sound principles.

Certain it is that such a demand greatly widens the responsibility of the architect, but, at the same time, it enables him to produce in a building as a whole that harmony of equipment without which no building can be said to be wholly complete.

The building is built for its containments, and the true designer certainly must have practically in remembrance the final use and object of every part of the structure to attain to anything like success in his undertaking, and also be able to guide and oversee it and its equipment to the final end.

By furnishing we do not mean furniture alone; furniture is only a part. Furnishing should embrace the whole equipment and decoration.

In this art of furnishing we remember at once the broad and great difference that lies between what is required in one building as against what is necessary in another, so that any rules that may

be here laid down should be sufficiently elastic to suit both place and circumstance.

The almost universal business practice of "choosing" the furnishings is not without serious danger to the ultimate use and appearance of any building. The system has, however, become so interwoven with modern customs that to lay it aside altogether is not fully to be recommended. At the same time it should be pointed out how necessary keen judgment and trained intelligence is to so choose and use the stock article as to produce harmonious results.

The marvellous expansion of modern machine-fed manufactories has well-nigh altogether laid aside many of the noblest traditions and methods of true craft work, so dear to the lover of good furnishing, and it is questionable whether, on the whole, it is not far better to direct our efforts more to the acquirement of a moderate amount of the very best craft work than to crowd into our buildings overfurnishing quantities of indifferent materials.

Moderation, therefore, should be the first rule of furnishing.

Trained taste should be the next, with a careful consideration for the fitness of things.

Color values are the next great consideration, and in this women rather than men often excel, as they must also necessarily excel in arranging the many domestic fitments that minister to the proper working of a house. With color lies well-nigh all the best possibilities of furnishing.

Then there is honesty of constructive purpose to be considered—a quality pre-eminently identified with the best of the old furniture, that men now collect and treasure, and wise men seek to emulate.

One other important fact should also be taken very seriously into consideration, and that is the great value and beauty of our Australian finishing woods. With scientific cutting, seasoning, and marketing they will be found pre-eminently suitable for the making of furniture and fittings, for, both in structure, breadth of variety, and richness of figure they take a very high place, and, with

growing knowledge of their use, should prove an ever-expanding asset in our best furnishing work. The question of seasoning must, however, have more consideration than has heretofore been given to it, for however good the timber may be, the work must prove unsatisfactory without thoroughly seasoned timber, and this can only be secured by proper cutting, stacking, and keeping during long periods of time, if not by some of the patent systems of seasoning, that have been worked from time to time in our midst.

Herein is where the imported timbers gain over the local article. They are for the most part more or less seasoned, and therefore offer, in this direction, more reason for their use than our own finishing woods.

In textile and wall paper design also we have much progress to make, as, for all general purposes, we have at present to rely too largely upon the imported article, which often shows, for this country, quite meaningless ornament. In this direction, our choosing should have in it more regard for texture and colour, and we should be able to set aside those ornamental *motifs* which are palpably unsuitable.

The broad fields of decoration should prove ever increasing in rich opportunity for designing and executing, in Australia, work entirely suitable to our own requirements, possessing, as we do, rich fields of suggestion in the various forms and colours both of the animal and vegetable kingdom, and in local atmosphere and life, which offer a new and extremely meritorious field for the artist.

The furnishing of public buildings, offices, and places of business do not call specifically for remark here, but the rules and broad principles laid down may find their reflex in these, as well as in the problems of domestic furnishing.

One overspreading character should certainly overrule such work, and that is—it should not be "domestic;" it should hold to a realm of its own, with strict utility, solidity, and dignity as the main considerations. The "domestic" may sometimes be "pretty," but the public building or private office hardly needs to be so.

Furnishing the House.—To apply some guiding rules, we may have in mind an average house, and offer some detailed remarks upon the various departments of the house, such as verandah, hall, drawingroom, diningroom, servery, breakfastroom, the library or den, the billiard-room, the boudoir, bedrooms, bathroom, stores, domestic offices, and outbuildings.

It must, however, be remembered that only general suggestions may be given here, and matters of color and style have at all times to be brought into harmony with individual taste.

The Verandah.—The verandah should be equipped with large, comfortable easy chairs of various kinds, and, being partly exposed to outside damp, if not to rain, all such equipment is best of an open and easy-drying character. For all general purposes, well-shaped wicker or cane chairs with arm rests are best. If the verandah be broad, or specially broad at one part, as verandahs at times may well be, lounges or folding deck chairs may be added. In speaking of verandah equipment, one has often noticed the need of some handy store, where the verandah equipment may be put away. With a little thought this could well be planned, free from dust, with much advantage to the tidiness of the verandah during the winter days. Specially made, well-fitting canvas blinds are nearly always of great service for closing in the verandah, and artificial light should also be supplied for evening use.

The Hall.—The hall, whether small or large, should also have careful attention, for it is here the visitor receives the first impressions of the house. The growing tendency of making the hall not merely a passage apartment, but an actual usable part of the house, may be considered, and the furnishing planned accordingly.

If of fair size, and the house be two-story, the stair should open into the hall, and should offer an opportunity for making effect with good woodwork. The general tone of the hall should be quiet, rather low in tone, solid rather than gay, substantial and dignified in general character.

To obtain this, a free use of dark finishing woods is recommended, showing natural color and grain, dull French or wax polished. Wainscoting (if not too expensive) looks well here, carried to the top of the doors, with some bold, painted, decorative wall treatment above.

For color scheme in the hall, the rich play of bronze and leather browns, relieved by a touch of red in the wall decoration, with a general atmosphere of quiet, solid colour, brown predominating, is well worth considering. The chairs, settle, and hall stands should be made of the same wood as the doors and stairs, and should be of the same general design, massive for the most part, but plain, yet good, and may be upholstered in leather, with close metal nailing. The best effect is obtained by having the windows of leaded glass, showing a quiet geometrical order, with but little color, preferably amber for the most part, with a slight touch of red to harmonize with the wall decoration. All metal work, such as handles, door plates, &c., should be made of special craft-worked, dull-bronzed copper.

The floor may well receive, after proper scrapers and mats have been provided in the entry for cleaning boots, a thick pile carpet of brown with a margin of waxed and polished floor showing around.

The Drawingroom.—If one room more than another in the house is in danger of being over-furnished, it is the drawingroom. Imagine the average drawingroom with 50 per cent. of the things taken away, and note the improved effect. Apply this simple and useful rule to most of the rooms we see, and we come to a rule holding in itself a great possibility of reform.

Drawingrooms, as also diningrooms, are now often planned to open by spacious doorways direct into the hall—an arrangement that has many points of recommendation for society use. Such an arrangement of planning, however, calls for special consideration in the furnishing, as the three rooms, when thrown into one by the folding or running back of the several leaved doors, must show

some harmony of treatment—a problem somewhat difficult of accomplishment, though not insurmountable, when it is known that harmony may be produced even where there is marked dissimilarity.

The drawingroom, taking on the character of its general use, should show lightness, gracefulness, and, if not carried too far, even prettiness of treatment, all woodwork, whether structural or of the furnishing, being treated alike.

If the prevailing color tone be dove grey and white, or yellow with lightly constructed old mahogany, inlaid furniture, some good treatment may be obtained, especially if the furniture be kept restrained in weight, and the ornament not too lavish.

Some good examples of water-color painting also may often find harmonious setting in the drawingroom.

Successful drawingrooms are most often those showing broken up planning, with apt creation of bay, ingle, and occasional seat, and outlook to some beauty of the garden.

The Diningroom.—Our diningrooms need hardly take upon themselves the ponderous solidity of old English baronial halls, yet some influence of the memories these call up may, perhaps, be allowed to our British fancy when the design of the diningroom is being considered. There may be a generous treatment with native woods, some panelled wainscoting and timber ceiling, with a nicely-designed fire-place linking up the two, and some bold carving over the open tiled fireplace, which is best fitted with wrought-iron grate and fire-irons.

The furniture should here be solid, showing sound, honest structure and good line and weight; the table so made as to look well when the cloth is removed, with secret castors and with thick and solid top.

An all-green diningroom looks well, with Queensland timber, stained and waxed, and upholstering of green leather, with a green carpet.

The whole, a cool, refreshing setting for its use, the generosity of

the table with its white linen, its glint of glass and flash of metal, the sideboard with its plate and its flagons, finds in the tone of the room some happy harmony.

Illustration.—If, as is sometimes desirable in country houses, a large common room be used for general purposes, as well as for dining, some interior treatment as illustrated in Plate XL. may be found harmonious.

This interior shows a spacious apartment with a bow window occupying one angle, looking thence into the garden beyond.

The walls are arranged with a deep frieze, having a molding below, and a wooden top cornice receiving the wooden ceiling beams. There is a massive wooden chimney piece and tiled fire-place in the centre of the left-hand wall, with a design carried up to the ceiling.

Two cabinets are so planned as to group with the room, and so detailed as to supply space for storage, so that the room may be usable for common purposes, the furniture of the apartment being designed to match.

Such a room would look well with a painted frieze, plain, flatted walls, polished floor margins, and plain carpet centre.

The Breakfastroom.—The breakfastroom should, in its aspect, welcome the glow of eastern light, and east and north is often a good position with a cheerful outlook.

It should be within easy access of the kitchen, yet entirely free from kitchen odors.

Brown and old gold are good workable colors, with rush-seated chairs of medium weight and with some arm chairs in pigskin.

The walls are best treated without pattern, and may be covered with coarse colored canvas in large panels, set in 3 in. by 1 in. wood bordering. These panels offer good background for suitable oil paintings, framed so as to be a distinct part of the room. The floor is best covered with a thick Indian red cork linoleum, and the open fire-place of brown majolica, and copper-mounted, wrought-iron fittings should give a finishing touch to a cosy and practical morning apartment.

The Billiard-room.—Even the billiard-room should feel some influence of new and rational design, in tune with the spirit of the house, for, while retaining all the essential elements of the game, some regard may well be made to modern taste and individual requirements. Where possible, therefore, the table should be specially designed. It need not have the stock-pattern, ponderous turned legs, all glassy with high polish, nor need it be always the same color. The table frame may be solid and restrained and without moldings, and the legs square, with good curved outline.

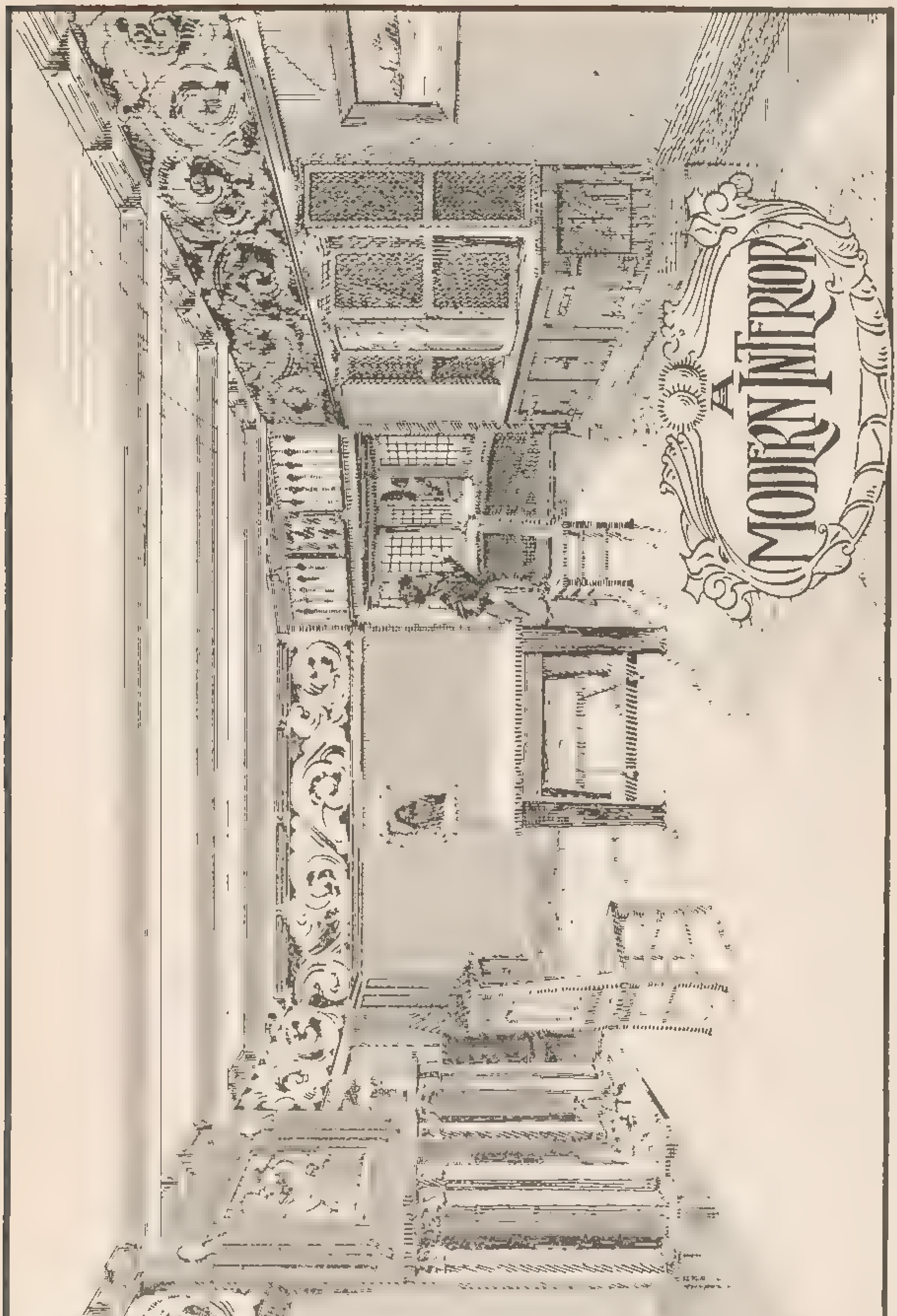
The whole equipment, too—scoring boards, cue racks, cupboards, settles, and the rest—may all be designed, together with the room, as a whole—one character and one tone.

The Library and Den.—The men who require libraries will generally have definite views about them wherewith to instruct the designer, varying, and depending in a large measure upon the special characteristic pursuit of the owner. A well-lighted room, with some restful color treatment and dignity of quietness, in some secluded part of the house, having direct outlet to the garden, is generally found best. There should be ample table and cabinet room, with generous plain wall spacing.

The den is often a modest substitute for the library, and is a very useful retiring room for the man of the house. Here individual taste will enter very largely, and no hard and fast rule can therefore be laid down for its design, save that the equipment should be worked out so as to minister in the best manner to the habits and inclinations of the owner, everything having a place, and the whole grouped in some harmony of general treatment.

The Boudoir, the lady's very own room, should reflect the exact personal taste of the lady herself, and here, more perhaps than in the other apartments of the house, actual personal taste may be displayed, for it may be taken as an established principle that certain persons prefer certain colors—certain colors find response in them, while others repel. There is, therefore, a color harmony for each individual, as, also, there is suitable dress, and color

PLATE XL.



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in dress, for fair or dark, tall, petite, or large, so these things may all be considered in design, and, if they are considered, nearer will the designer be to a happy harmony in the boudoir.

The Bedrooms.—The furnishing of the bedrooms should be specially directed towards the requirements of modern hygiene, and, as sun should during some part of the day be always allowed to fully flood the rooms, materials that are in any way specially liable to fade, should be avoided.

There should be as little furnishing as possible—a restraint almost amounting to austerity in equipment—yet this may not be at all out of harmony with beauty.

Floors are best of woods that lend themselves to wax polishing, such as extra dry hardwood, jarrah, or kauri, left without covering save here and there a warm rug or matting.

Walls should be treated with washable distemper in fresh, cool tones, or painted in flat.

Windows may have roller blinds, and, where the sun is troublesome, the outside hinged Venetian shutters are to be recommended. Inside curtains, hanging from poles, that catch dust, are highly objectionable. To ensure privacy, short curtains may be used across the lower portions of the windows.

Bedrooms should be well provided with permanent wardrobes, and there is no reason why the washstand and dressing table may not be made more permanent fittings than is generally the case. The bed should certainly be plain, and, as far as possible, of impervious material.

The Bathroom.—The bathroom should have that careful consideration which the climate warrants, and be of fair size, with certainly eastern aspect, with some north outlook as well, if possible.

The walls and floors should be of tiles, white predominating, with a touch of cool sea green or china blue, and with all corners rounded.

The bath should not be encased, but open all round for light, air,

and cleansing, and of cast iron fired, white *enamelled*, and with nickel fittings, all of these things—the tiles, baths, &c.—being now manufactured in Australia. If a bath-heater is used it is better to have it placed in a special niche in the wall.

For towel rails, both movable and fixed, and for clothes hooks, nickel is best, screwed through the tiles into the walls with nickel screws.

To obviate the use of curtains of any kind in the bathroom, the window may be glazed with obscure glass, and the artificial light so arranged that shadow cannot be cast thereupon.

A bathroom needs a seat, which is best of wood left unpainted, or a wood rim with caned centre, hinged to the wall, and fitted with attachments for raising and supporting when in use.

For floor mats, open rubber, cork, or wood open gratings may be used.

Soap and sponge cages should all be of open work, nickelled, and hung to the sides of the bath.

The lavatory basin should, like the bath, be quite open, all parts free from casing, and all of the visible metal may be nickelled.

Special tube outlet vents should be arranged from bathrooms, through or near the ceiling to above the roof, and this must not be forgotten for bath-heaters, for it is highly important that they should be separately ventilated.

The Domestic Offices.—All domestic offices, where culinary work is done, or where washing-up is carried out, should have walls made as impervious as practicable. Painted, varnished, or cemented surfaces are the best, with tiles at the back of the sink and where splashing may take place. Around ranges, tiles, or, better still, white glazed bricks, should be set.

All tables, draining boards, dressers, and every kind of woodwork in the fittings are best left virgin for scrubbing, and for this, clean, dry, hand-dressed kauri is recommended.

Hooks, rods, and similar fittings are best of nickel, which needs only wiping to keep it in good appearance. All utensil equipment

is best in aluminium, so arranged on nickel hooks from wooden rails as to hang against the tiled portion of the walls.

In china, glass, and silver pantries, glass-fronted cabinets should form a large part of the permanent equipment, with proper drawers and table tops of waxed or dull French polished woodwork.

The Servants' Quarters.—In the servants' bedrooms the walls should be treated with washable distemper; the drawers, dressing-table, washstand, &c., being made as a part of each room, and, as far as possible, permanent fittings, plain in design, but well fitting and suitable. Kauri is a good wood for all this work, finished in encaustic varnish. The floors should be covered with plain, heavy linoleum, with matting strips laid over. and the bedsteads made of iron, but very plain.

The servants should, wherever possible, have their own bath, which should be an open one (no casing). The walls may here be cemented to a glass face, and the floor laid with 3 in. by 3 in. red tiles, or, if an upper floor, with lead.

All equipment may be cheaper than for the general bathroom, but the same principles of impervious surface and openness should be applied to both.

For the servants' sitting or dining room, a good, substantial furnishing of plain, stained, and wax-polished kauri furniture answers well, with chimney piece, cupboards, &c., all designed together; walls covered with sanitary paper of restrained design, and with a floor covering of plain linoleum.

The Outbuildings.—Outbuildings should be equipped in the same spirit of honest solidity as will accord with the house itself, thus preventing the usual spirit of temporality and neglect to characterize these lesser adjuncts of the house.

CHAPTER IX.

GARDENING.

Strong advocates should at all times be found to press forward the great value of tree-planting and garden-making in Australia.

In the hot and dusty days, how the eye seeks for the green shades, the shadow of trees, and the shelter of their over-spreading foliage!

The streets that are lined with trees are the streets we seek. The cooling influence of plantations and public garden reserves is eminently for the public health and good.

Australia is justly proud of her public gardens, where municipalities vie with each other in the use of Nature's rich luxuriousness for the delight and pleasure of the public, and this public interest in gardening cannot be without strong influence upon the individual, for public gardening finds its echo and reflex in the gardens of the people.

To the man who builds, therefore, it is natural to garden, and if the building be in any way a detached structure, he may, with thought and some care, garden both wisely and well.

Now, the creating of a garden is second only in importance to the building of a house, and the two—the house as a well-balanced structure and the garden as a well-laid-out frame—should find harmony the one with the other; and as the house answers through the years to the kindly mellowness of Nature's touch, so may the garden grow up in strength and beauty to minister to the household her meed of beauty and repose.

In thinking of garden design it should be remembered that a garden may be planned as a house is planned. It is, in a measure, only a difference in materials with which the designer has to deal.

In the house is inanimate material, in the garden the possibilities of life and growth; and both may be used to answer to the designer's skill.

There are styles of gardening as there are styles in house-building, so that the successful garden should answer, first of all, to the style of the house, and as the style of the house should be appropriate to the locality, the site, and the climate where it is situated, the garden also should in this way follow upon the same lines.

One of the first things to be remembered in our gardens is that they cannot be "Nature." The garden, like the house, is artificial. The materials for the house are from Nature certainly, but not as Nature made them, for they show the hewing and forming of man's hand, and so with the garden. There certainly is growth and life, but it is life bent to the conventional life and limitations of the garden. The next step is easy. It is to realize that the most successful gardens are those that act as a well-planned link between wild nature and the building, softening the tangle of the one and toning down the hardness of the other by the interposition of its own harmonious self.

House Gardens.—The making of a garden will be governed by considerations of locality, size and shape of site, levels, nature and depth of soils, boundaries, roads, and right-of-ways, as also by the planning of the house which it serves.

In considering levels it is important to wisely weigh this great factor in the garden, to take any advantage of natural falls, or to create new ones as required.

The preparation of the ground for plant-growing is of all things most important, and the greater part of the work in making a garden should be directed to properly trenching and draining the land, and taking out unsuitable materials, and to the bringing in of good plant food, so that there may be a lasting foundation for the garden to grow upon, for no amount of surface labour in the future will compensate for the neglect of this work at the beginning.

Gardens may often with advantage be divided by some broad subdivision into various more or less distinct sections, such, for instance, as the wild garden, the kitchen garden, and the orchard; or portions may be set aside for special purposes, such as the tennis or the croquet lawn, or spots so arranged and planted with hedge and heavy growths as to specially secure their privacy from the rest of the garden.

The associations of old world gardens cluster around many more or less artificial forms that may often be used with advantage in the planning of new work. There is the terrace, with its broad gravelled expanse, next the building, enclosed by its low perforated wall; the steps that carry from one level to another; the walls that divide one section of garden from another, against which fruit and flower may grow; sundials, that with us may find more sun wherewith to point the time of day than those in old world gardens. Summer-houses and seats that induce repose, and dovecotes wherein feathered life may find home and shelter. Then there is the lily pond and the gold fish pool reflecting the glory of the flowers and the changing of autumn trees.

Statuary, if well chosen, makes for beauty in the garden, especially when backed, as in old Italian gardens, with the dark green shading of the cypress and the pine.

The "*ultimate*" is the greatest of all considerations to be remembered in practical gardening, and here, in a very special manner, should the designer have the skill of the horticulturist.

When the garden is newly set out and showing only formation—bare soil without growth—it is highly necessary that faith which sees to the end, and knowledge, which, from experience, sees in the mind's eye the "ultimate," should determine the place and the distance apart of trees and plants.

This is a quality of training that only a certain gardening experience can give, and is highly important; for not only must the nature and growth of trees and plants be thoroughly understood, but the question of aspect and suitability of position must be

carefully weighed, so that a fair and equable estimate may be made of the probable effect of the garden with regard to coloring, density, mass, and sky line, when all that has been planted shall have come to proper maturity in the years to be.

Apart from the plant-growing there are questions that enter into the structure of every garden which may also be briefly touched upon, such as boundaries, entries, paths, drives, margins, drying grounds, &c.

And, first, as to boundaries, it is much to be regretted that we pay such limited regard to the building of our boundary divisions that, even with houses costing many thousands of pounds to build, the street line is generally marked by a cheap picket fence or galvanized iron enclosure. This, we venture to think, could well be improved upon, when we remember the possibilities of brick walling and wrought-iron railing, which may be made so much more in harmony with a well-built house than such cheap and temporary fences as are generally employed, and which are not in any way redeemed by the juxtaposition of elaborate entrance gates. If the custom of setting aside a proper sum of money for the boundary walling and entrance gates, when building is being carried out, was more often adopted, a very admirable reform would be introduced, and one more worthy of the houses we build.

But whatever the fence, the entrance gates should be well designed, for through them all visitors to the house pass, and consequently the gate is an object that comes under close observation and use, and is a feature that can be made much of, if happily treated, either in itself or helped by nature with hedge flanking and overarching canopy of green.

We grow so used to the ordinary paling fencing that invariably encloses a building site upon most of its three sides that we are accustomed to look upon such a fence as inevitable, yet in itself it is distinctly ugly, and we cannot help thinking that some more direct effort should be made to "plant it out," or, if not to plant it out, to do away with it altogether. With the incoming of some

admirable taut wire systems of open fencing now upon the market, we cannot help seeing great possibilities of improvement if something of the kind could be more largely used to mark boundaries between adjoining owners. These wire fences are very rigid, and so arranged near the ground as to keep dogs from passing through; they also offer an admirable division, next which hedges may be planted, and so grown as to be seen equally well from both properties. Where paling or galvanized-iron fencing is used, it may with advantage be covered with open mesh wire netting, upon which creepers may be grown. It will in this way be made to form a pleasing background for the lower portions of the garden.

Entries.—Entries are best arranged so as to induce separate approach.

The general entry, being the most important, should occupy the main position, and its approach and path be so planned as to command the best view of the house.

The tradesmen's entry should be quite away from the general entry, and the paths to kitchen offices screened, or planted out, from other portions of the garden. Such paths should also be kept away from such portions of the building as bedroom windows, where early calls would disturb the occupants.

Cart entries on ordinary suburban allotments should not be planned direct from street, as the roadway so formed is only casually used, and is often difficult to deal with, offering, as it does, an ugly gap in the garden without much corresponding value. Such entries are best made, if at all, from right-of-ways, with internal roadways so planned as to serve fuel store and manure and rubbish bins.

Paths.—Garden paths should be made as little conspicuous as possible, and not too wide, or excessive in snakiness. As both color and line, they may be made very useful in the general design of the garden. In material they should, as a rule, have hard, solid foundations, and be crowned and side-drained, in order to carry off the

rain water. Tar asphalt is not recommended, it being too hard looking, and inharmonious in color.

Gravel paths look best, for all general purposes, if the weeds are kept down, while in some positions, such as narrow ways between beds, grass paths may be used with advantage. Brick paths, if well laid, make sound paving to domestic offices, while terra-cotta, stone, or slate slabbing may be used in straight paths, especially where they lead direct from streets. Thickly laid tan is not without its use as path covering. If contained between high margins it is dry, and, being good in color, harmonizes with the green of the garden.

Drives.—Drives should always have easy gradients and safe curves, and be formed generally in the same way as light traffic roadways, topped with well-rolled gravel, and side-drained with glazed stoneware, brick, or stone channeling.

Margins.—For path margins, various devices have to be resorted to, to prevent soil encroachment. These are best dealt with by the growth of border plants, or turf strips; the use of terra-cotta ornamental edging is not recommended, it being too conspicuous and fussy, while wood edging, though very useful, is inclined to look set and hard in the garden. In certain positions, rocks or old tree limbs may with advantage be utilized for this class of work.

Drying Grounds.—In the design of a practical garden, the claims of the laundry should not be forgotten, and proper provision should be made for the drying of washed linen. The posts and lines are inclined to prove conspicuous, if not skilfully arranged, and yet, in the average garden, there is hardly sufficient room, nor is it altogether desirable, to devote a special space for this purpose alone. In some instances movable posts, fitting into ground sockets, are put up for use on washing days, but this requires manual labor, and has consequently some disadvantages.

The better way, perhaps, is to have permanent posts erected, and to use galvanized wire lines, which may easily be taken down when not in actual use. Drying grounds should be clear of

shrubs or trees, and as dry underfoot as possible. For this reason the ideal drying ground covering is gravel. If over lawns, the grass should be kept closely shorn.

Storage.—No garden is complete, as no house is complete, without storage room. The tidiness of a garden greatly depends upon having a proper place for all garden tools and implements, rubbish receptacles, pits for manure, where everything not required in the garden proper, may be put away. A small yard planned with enclosed sides and close gate entrance, planted out from the rest of the garden, large enough to contain a weather-tight tool house, potting shed, seedling beds, glass frames, and storage for sticks, pots, &c., also spaces for dead leaf soil and manure storage, is generally the best for this purpose.

Watering.—It may be taken as a truism that no garden in Australia can be maintained without artificial watering, and provision for this should be carefully thought out in every garden. Whatever the water supply, it is better arranged by a thorough system of underground galvanized-iron piping, carried to all important points, with stand pipes and taps, ready for hose attachments, which from them should reach every part of the garden. In addition to these, much time may be saved by the laying above ground, in such places as at margin edges, of long horizontal lengths of perforated piping, from which spraying may be carried out without the labour of hose-carrying.

Draining.—It should be remembered that draining is as important as watering, and full provision should be made, when the garden is formed, for dealing with this important matter, which will very largely depend upon quality of soil, position, mean average rainfall, and natural levels of the site, as well as upon any artificial levels that may be created by the forming of the garden.

Light, open, sandy, gravelly and loamy soils are, to a great extent, self-draining, while clay and heavy soils hold water, and tend to sourness in the wet seasons. The object of drainage is to break these up, and to induce the superfluous water to get away.

This is best done by the systematic laying below ground of agricultural pipes. These are of terra-cotta, plain, circular, and without end sockets. They should be laid with open joints, so that the water may enter the pipe run at any joint, and so laid to falls as to carry water to lowest points and to natural outfalls.

Shade Houses.—For certain kinds of plant-growing the shade house is necessary in our gardens. This is best built of such woods as do not require painting, as painted woodwork is more or less out of harmony with the garden. Most of our natural woods stand outside weather well, and, after a time, turn to silver-greys that harmonize particularly well with green foliage. They are therefore very much better left unpainted.

To build a shade house, a strong, well diagonally braced skeleton frame should be set up. This is best built upon jarrah or red gum ground stumps, or stumps of any wood that will not rot when buried in the ground. These should be about 4 ft. apart, with a plate on top, with vertical uprights for walls 3 ft. 6 in. apart of 4-in. by 2-in. hardwood, or other suitable timber, 3-in. by 2-in. horizontal rails every 2 ft. 3 in. in height, and the same system for roof. Everything should be diagonally braced with 3-in. by 1-in., and the whole covered with 2-in. by $\frac{1}{4}$-in. red Californian pine battening, set open $\frac{3}{4}$-in. apart, and at right angles (not diagonally). This, if left to weather, will look well and properly serve the purpose. The internal tables and shelves are best made of stout open battening,

Summer Houses.—In dealing with the design of summer houses and garden shelters, it is well either to keep to the use of natural, unsawn timber or to use entirely sawn timber, for it is a matter of observation that the one clashes somewhat crudely with the other when used in the same connection.

Where sawn timber is used our own eucalypti offer the best materials—not painted, but allowed to go their soft silver greys, This, with shingled roofing, tends to nice color tone.

On the other hand, few objects are more picturesque than a

summer house built of natural unsawn timber, the limbs of old trees, bark, and any oddments from the bush, put together with some taste and judgment, and roofed with straw thatch. Such a house seems a veritable part of Nature and of the garden.

In placing summer houses regard should be given to seclusion and shelter from excessive heat and disagreeable winds, but the placing of the entry should, where possible, open out a vista of the garden's loveliness, knowing the value of a sunlit and color picture framed and viewed from the cool shade of the house interior.

Conservatories.—The demand for a conservatory, attached to a house, is one often brought within the scope of the architect's work; but, whether attached to a house or designed as a separate building, the horticulturist should always be consulted, to determine points of light, aspect, and equipment. The permanent upkeeping and maintenance of such buildings should be at the outset carefully weighed, as few things are more unsatisfactory than a neglected conservatory.

Both in conservatories and hot-house structures, where much glass has to be used, and the building is specially subject to the action of direct heat, careful attention must be given in the construction, to counteract the moist heat of the interior and the more often dry heat and wet of the exterior.

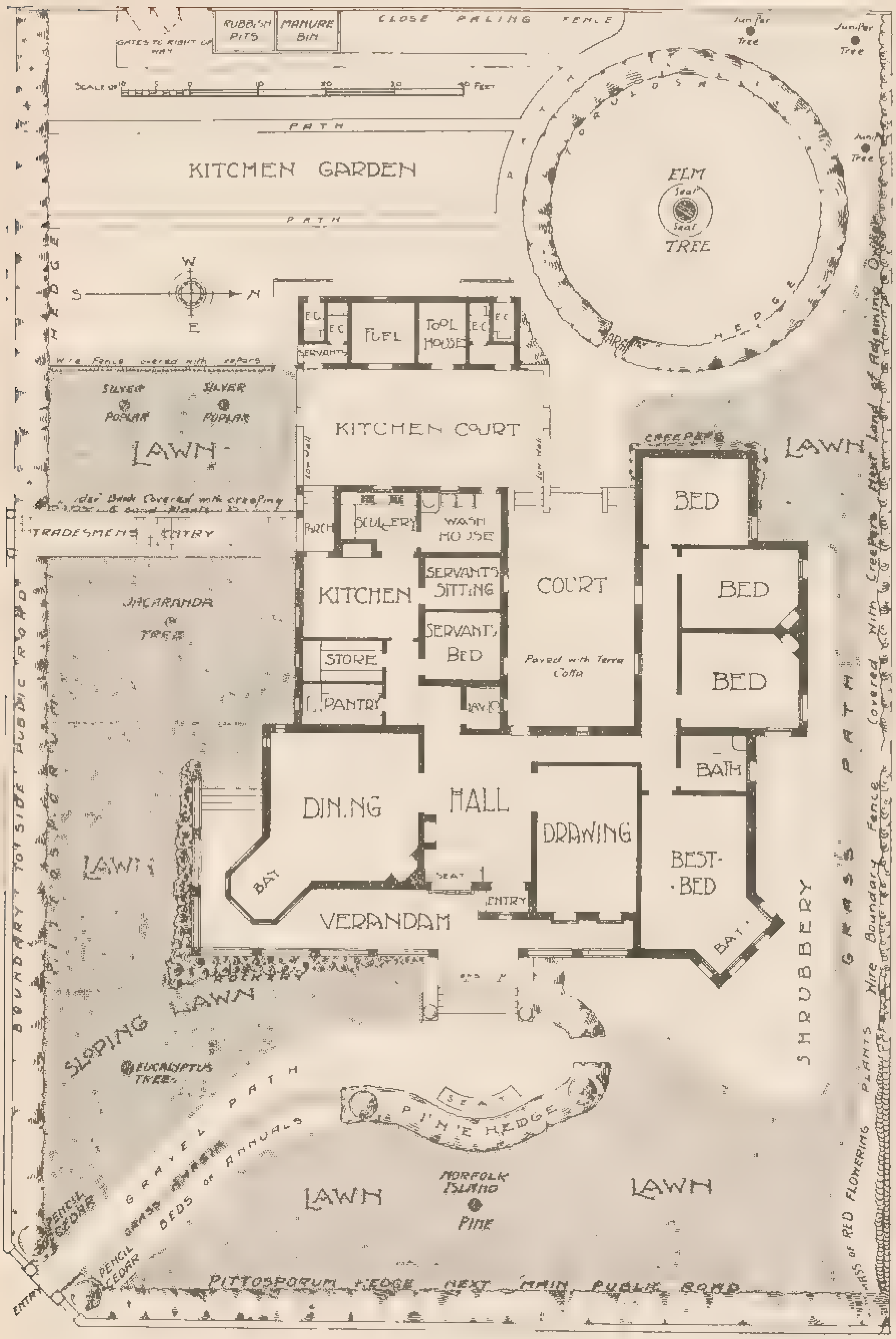
For all general woodwork red Californian pine is, perhaps, best, for this wood, though soft, is a good lasting wood for exposed and outside positions.

Putty, in the glazing, should, as far as possible, be avoided, as it perishes rapidly. For this purpose some of the systems of metal glazing bars are the best. These are devices of metal to carry the sheets of glass without putty, as also to carry away the inside condensation.

For roofs the best glass is wired plate—*i.e.*, glass in which wire netting is imbedded in the centre of the sheet, making it strong, to resist hailstones.

Pools.—The creating of artificial pools of water is often the

PLATE XLI.


RUBBISH PITS
MANURE BIN
CLOSE PALING FENCE
Juniper Tree
KITCHEN GARDEN
PATH
ELM TREE
HEDGE
W
S
N
E
E.C.
FUEL
TOOL HOUSE
SILVER POPLAR
LAWN
KITCHEN COURT
TRADESMENS ENTRY
BED
SCULLERY
WASH HOUSE
KITCHEN
SERVANT'S SITTING
SERVANT'S BED
COURT
Paved with Terra Cotta
STORE
PANTRY
DINING
HALL
DRAWING
BATH
BEST-BED
BAY
VERANDAH
ENTRY
JACARANDA TREE
SHRUBBERY
SLOPING LAWN
EUCALYPTUS TREE
GRAVEL PATH
BEDS OF ANNUALS
PINE HEDGE
SEAT
NORFOLK ISLAND PINE
PENCIL CEDAR
ENTRY
PITTOSPORUM HEDGE NEXT MAIN PUBLIC ROAD
BOUNDARY TO SIDE PUBLIC ROAD
GRASS PATH
Wire Boundary Fence Covered with Creepers Next land of Adjoining Owner

means of introducing a pleasing feature into the garden. These pools may be either of large or small extent, and may be supplemented by rockeries or fountains.

No great depth of water is necessary to give effect in a pool. A few inches will give all the beauty of mirror reflections, but if a pool is to be used for golden carp or aquatic plants, some greater depth is necessary.

Pools need careful building, away from the influence of large tree-roots or unsuitable soil, that may cause fracture in the foundations. They are best formed of good concrete, rendered hard and smooth inside with Portland cement and sand worked with a steel trowel to glass face.

Rooteries.—Gathering together stumps and roots of old trees, dead tree-ferns, or rocks, and setting them up as mounds or bluffs in the garden, often makes for pleasing effect, as the crannies, if filled with soil, offer suitable positions for many creeping plants, and shelter for mosses and lichen.

Seats.—No garden is complete without some permanent seating, and many are the types identified with old gardens, made either of stone, wood, or iron. For our gardens, perhaps, the natural woods are best, so constructed as to offer a maximum of ease to the average person. The straight back and level seat has long and ancient usage for its precedent, but, for comfort, perhaps the curved back and seat offers the best results, especially when supplemented with arm rests.

Seats are best designed with open railings, so as to be kept as dry as possible. They should be in positions, for the most part, slightly raised from the surrounding levels, and have wood foot gratings in front.

GARDEN PLANS.—Plate XLI. shows the plan of a moderate-sized villa garden, upon land having a frontage of 132 ft. to the main road, with a depth along a side street of 198 ft., and with a right-of-way at the rear.

The building is placed some 55 ft. from the main road, and is also kept well back from the side street. This gives good opportunities for front display, and generous green setting for the house, which is of red brick with tiled roof—a treatment requiring the cool framing of Nature's greenery to show it to the best advantage.

The principal entrance is from the S.E. angle, where the boundary walling of low brickwork with ironwork on top meets in a wrought-iron gateway.

This gateway is flanked by two high pencil cedars, which rise high above the pittosporum hedge that encloses the S. and E. boundaries.

The front path gradually winds and rises to the verandah steps, which are screened from the street by a close pine hedge, having shaped end pieces rising above the general level, and a seat in the centre.

By this arrangement of entering, the visitor obtains a good first impression of the house, from a favorable point of view, and the house is grouped so as to look specially well from this position.

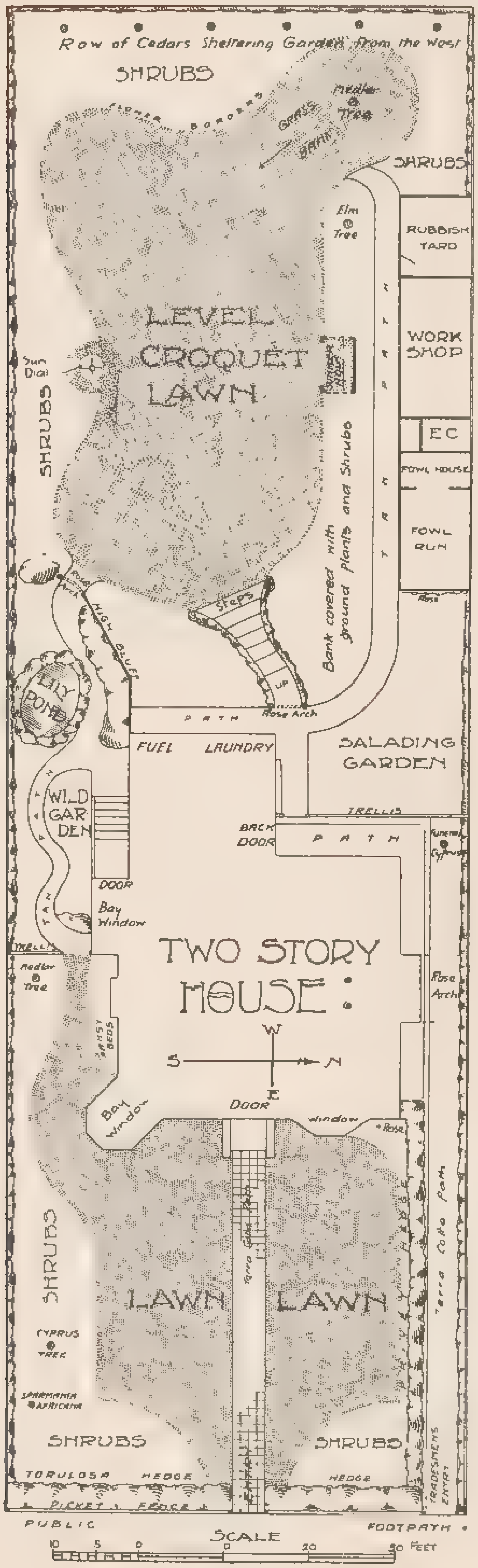
It will be noted that there is considerable fall from back to front, and that the garden is broadly subdivided into the kitchen garden at the S.W. and a sheltered garden at the N.W. corner, where summer shade and seclusion is obtained, within the circularly planted torulosa hedge, and under the shade of the elm tree.

There are also paved courts—one for the house proper, where trees in tubs could be planted, and the kitchen court, which is used for laundry and general purposes, and offers a link between the working part of the house and the outbuildings.

The plan as a whole, if carefully studied, will be found to offer several useful suggestions for a villa garden of moderate dimensions.

Plate XLII. shows another garden design. In this case the land has a frontage of 55 ft. to a public road by a depth of 183 ft., surrounded on three sides by adjoining owners. The house, which is of two stories, faces east, and is set back about 45 ft. The land has a somewhat abrupt fall from the house itself to the S.W. corner.

PLATE XLII.



Row of Cedars Sheltering Garden from the West
SHRUBS
FLOWER BORDERS
GRASS
SHRUBS
Elm Tree
RUBBISH YARD
WORK SHOP
EC
FOWL HOUSE
FOWL RUN
LEVEL CROQUET LAWN
Sun Dial
SHRUBS
Bank covered with ground Plants and Shrubs
Steps
UP
HIGH BLUFF
LILY POND
PATH
Rose Arch
FUEL
LAUNDRY
SALADING GARDEN
TRELLIS
WILD GARDEN
BACK DOOR
PATH
DOOR
Bay Window
TWO STORY HOUSE
Rose Arch
W
S
N
E
Bay Window
DOOR
Window
Rose
SHRUBS
LAWN
LAWN
Terra Cotta Path
CYPRUS TREE
SHRUBS
SHRUBS
TORULOSA HEDGE
HEDGE
TRADESMENS ENTRY
PICKET FENCE
PUBLIC FOOTPATH
SCALE
10 5 0 20 30 FEET

This design, as a whole, well shows what variation of mass and surface can be planned into a garden contained within a long and narrow allotment of land. The main entry here is straight, and in a direct line from the front gate, along the terra-cotta path, to the entrance door.

The front garden is screened from the road by a high, close, torulosa hedge, and the tradesmen's entry at the N.E. corner has a path, screened from the general garden by a privet hedge. The green front lawns are shaped to curves, and run up to the house, being flanked by broad beds, containing large shrubs, with borders of flowering plants.

No climbers are allowed upon the building itself, which is of red brick, with green slate roof.

Trellis screens cut off the front from the back garden on either side, the tradesmen's path being confined to an easy way from the street along the north side of the house to the back door and the trellis gate.

The trellis screens are covered with creepers, as also are the whole of the boundary fences, which arrangement tends to a more expansive and less shut-in appearance in the garden.

To the immediate south of the house, near and towards the back, a wild garden is planted, so arranged as to present a complete little garden in itself, hidden by the high wire screen covered with creeper, and by the bluff and rockery, from the back garden, and having a deep winding path around the tangle of the undergrowth.

A bay window of the house overlooks this wild spot, and a door opening off leads down a flight of steps to the lily pond—an oval-shaped concrete pool, overshadowed with wistaria and bridged by an old log.

The main portion of the back garden is specially levelled and turfed for croquet, with garden beds around, and a high-set loop to the N.W. corner, from which to view the game, having an old tree stump in centre covered with climbing roses.

A row of cedars along the back boundary serves to cast afternoon

shade from the western sun across the lawns—a feature much needed when the lawns have afternoon use.

The outbuildings are arranged upon the highest portion of the land at the back and along the northern boundary, and these, and the laundry and fuel, are served by a tan path, which breaks down by broad steps to the lawn.

A central summer house, sheltered from the north, is set in the sloping bank which surrounds the lawn on the east and north sides, and opposite is a sundial well open from all shadow.

From a careful study of the art of Australian gardening, we may conclude that the gardens of moderate size, which are likely to give most satisfaction, are those mainly planted in such a way as to maintain permanence of character. These should therefore be well formed, thoroughly prepared, and so planted with permanent shrubs and trees, and laid with grass, as to offer, apart from flower-growing, a pleasing and stable work.

A garden mainly planted for flower-growing is most difficult to sustain during the great heat of summer, and calls for far more continuous attention, expense, and effort than can generally be given to it. For this reason a more or less sheltered garden, where both natural and artificial moisture is conserved, and where shade and shelter is provided, offers the best atmosphere for a pleasing garden, where sufficient flowers may grow to give that variety and beauty of color which the background of permanent planting does so much to heighten and sustain.

The house itself is a great shelter for the garden, and its four sides offer four differing conditions for plant growth, and if the house, with the weather of years, tends to decay, there is the compensating life and vital renewal in the garden, where the song-birds love to dwell, and where the sweet odors of the flowers come and go with the seasons of the changing years.

Part II.—Construction.

Consisting of CHAPTERS X. to XXII. (Inclusive).

CHAPTER X.

BRICKWORK AND FOUNDATIONS.

Soils.—The soil upon which a building is to be erected should always be carefully examined to determine its nature before the foundations are designed or put in.

The points to note may be laid down as the following :—

(*a.*) Uniformity of quality.

(*b.*) Density of structure.

(*c.*) Weight-bearing capacity.

(*d.*) Porousness.

(*e.*) Natural or artificial foundation.

It must be remembered that earth is elastic, capable of being affected by added weight, is also charged with moisture and air, and is capable of being variously affected by openness of its surface to atmospheric influences, or, on the contrary, protection of its surface by building.

A building therefore affects the soil upon which it is built, firstly by its weight, and secondly by its interference with its density of contained moisture.

Good Soils.—The best soils for building are those that are uniform—*i.e.*, of the same nature throughout, as nothing interferes so much with the stability of a foundation as inequality of soil.

In this class may be placed rock (if sound), gravel, sand (if contained). These soils have the further advantage of not holding moisture.

Bad Soils.—Clay, if deep enough below the natural surface to be away from atmospheric influence, is generally considered a reasonably safe foundation. Where, however, the clay is close to the

surface, it is alternately swollen by the absorption of moisture, and shrunk, and baked, and cracked by the drying action of sun heat, and thus becomes most unreliable.

One of the worst foundations is where the clay is found mixed, as sometimes occurs, with large stone boulders. This is the acme of inequality, and calls for very special treatment.

Soils on low-lying lands, near tidal rivers, are often of a treacherous nature, being charged with varying quantities of water. Yet, as warehouses and commercial buildings have often to be erected upon such soils, some scientific way of dealing with them has to be devised.

Bad Foundations.—Where bad foundations are met with, certain special means have to be adopted to secure the stability of the sub-structure. These means often enter somewhat more within the range of the civil engineer's than of the architect's practice, and may consist of one or other of the following:—Pile driving, deep sinking, reinforcing, or rafting.

Pile Driving.—Where stability is obtainable at a low depth beneath the surface, wooden piles are sometimes driven in, cut off horizontally fair, and laid with heavy timbering, upon which the walls are built.

Deep Sinking.—Another method is to sink the trenches through the unreliable material, which is temporarily shored up and sheathed with timbering as the work proceeds. When a solid bottom is reached a good depth and width of concrete is thrown in and levelled, upon which the walls are raised in the usual way.

Reinforcing.—Since the introduction of reinforced concrete as a constructive factor, bad foundations are often dealt with by building a wide-spreading network of reinforced concrete under all walls, as widespread as is consistent with the weight borne and the nature of the soil requires. This network consists of properly placed steel bars bedded in concrete.

Rafting, which is occasionally resorted to, consists in practically

floating the building upon the surface of the unstable soil. This may be done in several ways, such as upon heavy red gum planking or by broad concrete reinforcing.

Normal Foundations.—A normal foundation for walling is generally made by excavating the soil to a suitable depth, which is termed "excavating trenches." These trenches are afterwards partially filled with concrete, upon which the walls are supported.

Trenches.—Trenches are cut out dead level and of the exact width of the concrete. In the case of ground with surface falls, the trenches may be "stepped"—*i.e.*, carried along for a certain distance and then dropped at right angles down to a lower level. Such level, in the case of brick walls, should be equal to brick courses and not more than about three courses in depth.

Trenches should be clean cut and kept free from falling earth or water when the concrete is put in.

In the case of rock foundation or very hard, sound soils the concrete may be dispensed with, and the brick footings of walls laid in at once, or a course of large flat stones be substituted for concrete. In any case the foundation trenches must be taken out to form a level bed.

Concrete and Concrete Mixing.—Concrete is a conglomerate mixture, generally consisting of cement or lime, broken stone, and sand, designed to form a continuous and homogenous mass when set.

Setting.—The setting—*i.e.*, the drying and hardening—of concrete depends chiefly upon the nature of the cementing material used. Generally speaking, cement concrete sets quicker and harder than lime concrete.

Sand.—Sand for concrete should be entirely free from salt or loam, and should consist of coarse, sharp grit.

Cement.—Cement for foundation concrete should be "Portland," tested before use.

Lime.—Lime should be fresh burnt and so "slaked"—*i.e.*, mixed

with water—that its active properties of expansion may be completely exhausted. Lime if not properly slaked is liable to "blow" —*i.e.*, slake—when it is in the work, and cause disintegration.

Metal.—Metal is a term applied in a general way to stone used in concrete. This stone should be specially hard, such as granite or bluestone, broken to specified gauges, usually in the case of foundation concrete from 1½-in. to 2¼-in. gauge, according to the class of work in which the concrete is used. Should hard stone not be available, clean gravel, clinker, broken bricks, or other substances of a like nature may be substituted.

Concrete Recipes.—The following are recipes for foundation concrete :—

Cement Concrete.—One part of Portland cement to two parts of sand; three parts of hard broken bluestone metal, 2¼-in. gauge.

One part of Portland cement, two parts of sand, four parts of coarse bluestone screenings.

Lime Concrete.—One part of well-slaked, fresh-burnt lime; four parts of thoroughly clean gravel and sand, free from loam or salt.

One part of approved ground hydraulic lime, two parts of sand, two parts of coarse granite screenings.

Method of Concrete-Making.—The process of making concrete must be rigidly directed towards cleanliness. No loam or dirt must come into contact with the material, for cement and lime will not adhere where these substances exist.

The ingredients, therefore, should always be mixed upon a close wooden floor.

The cement, sand, and other dry materials should be equally measured in gauge boxes. These are measures of wood without bottoms or tops, consisting of boarded sides with handles.

After thoroughly mixing the whole dry, water should be added evenly and gently through a spray nozzle hose or watering can, the whole, meanwhile, being well turned over and mixed together.

The same method is adopted where ground limes are substituted for cement.

Where ordinary lime is used it is first slaked in a wooden mixing box, from which it is run out in liquid form on to the other materials.

Concrete should be thrown into trenches from a height, spread, and gently rammed into position, levelled, and allowed to set before walls are commenced.

Floor and other Concrete.—For floor concrete, concrete lintels, &c., see chapter on "Concrete Construction" (Chapter XII.)

Bricks.—To describe the various manufacturing processes adopted in the making of bricks is not within the scope of this work.

Bricks vary according to the class of material used, as also in the mode of their manufacture. Those for general structural purposes are best made from clay reef, under hydraulic pressure, and burnt in Hoffmann kilns.

Hand-made bricks, as also ordinary machine-made bricks, are more liable to show less density of structure than the above.

A good brick should be heavy in weight, close in structure, true and square, with sharp, well-kept arrises, and should be reasonably non-absorbent. For all visible face work bricks should be selected of good and uniform color.

The standard size for bricks in Australia is 9 in. by 4½ in. by 3 in., with a frog on one side—*i.e.*, a shallow sinking—to form key for mortar.

Special Made Bricks.—In addition to ordinary bricks special bricks are also manufactured for various purposes—first, those of special color, and, secondly, those for special purposes. Of the first class there are white, black, chocolate, special red, and other colored bricks. Of the second class are special made bricks of various kinds, such as radiating arch bricks, coping bricks, splays, squints, also molded bricks required for use in varying ordinary plain brickwork.

Illustration of Bricks.—Plate XLIII. illustrates bricks of different kinds, made, shaped, and molded for various purposes.

No. 1 is the ordinary brick of commerce, which is made with a fair hard surface on the four sides. The bottom of the brick is plain, and may be less smoothly finished than the four sides. The top has a shallow sinking called a "frog." This is always laid uppermost in the walling, and, being filled with mortar, creates a "key" or hold.

No 2 is a "king closer," a special made brick, chiefly applied in the making of bond in reveals. An illustration of its application is shown in Plate XLVI., fig. 4.

Nos. 3, 4, and 5 are rough splays, mostly used to project and carry horizontal cement moldings.

No. 6 is a squint brick, used at external angles that are not right angles.

Nos. 7 and 8 are splays used chiefly in plinth courses.

Nos. 9 and 10 are base or plinth molds.

Nos. 11 and 12 are two different kinds of bricks to be set "on edge" for copings or top finishing of walls.

Nos. 13 and 14 are for splayed and molded jambs respectively.

Nos. 15 and 16 are bull-nosed—*i.e.*, quarter round-cornered—bricks, much used for external vertical angles.

Nos. 17 and 18 are top member molds, suitable for cornices.

Nos. 19 to 29, inclusive, are various forms of molds for general use in cornices, string courses, &c.

Nos. 30, 31, 32 are necking molds, or, reversed, may be used for base molds.

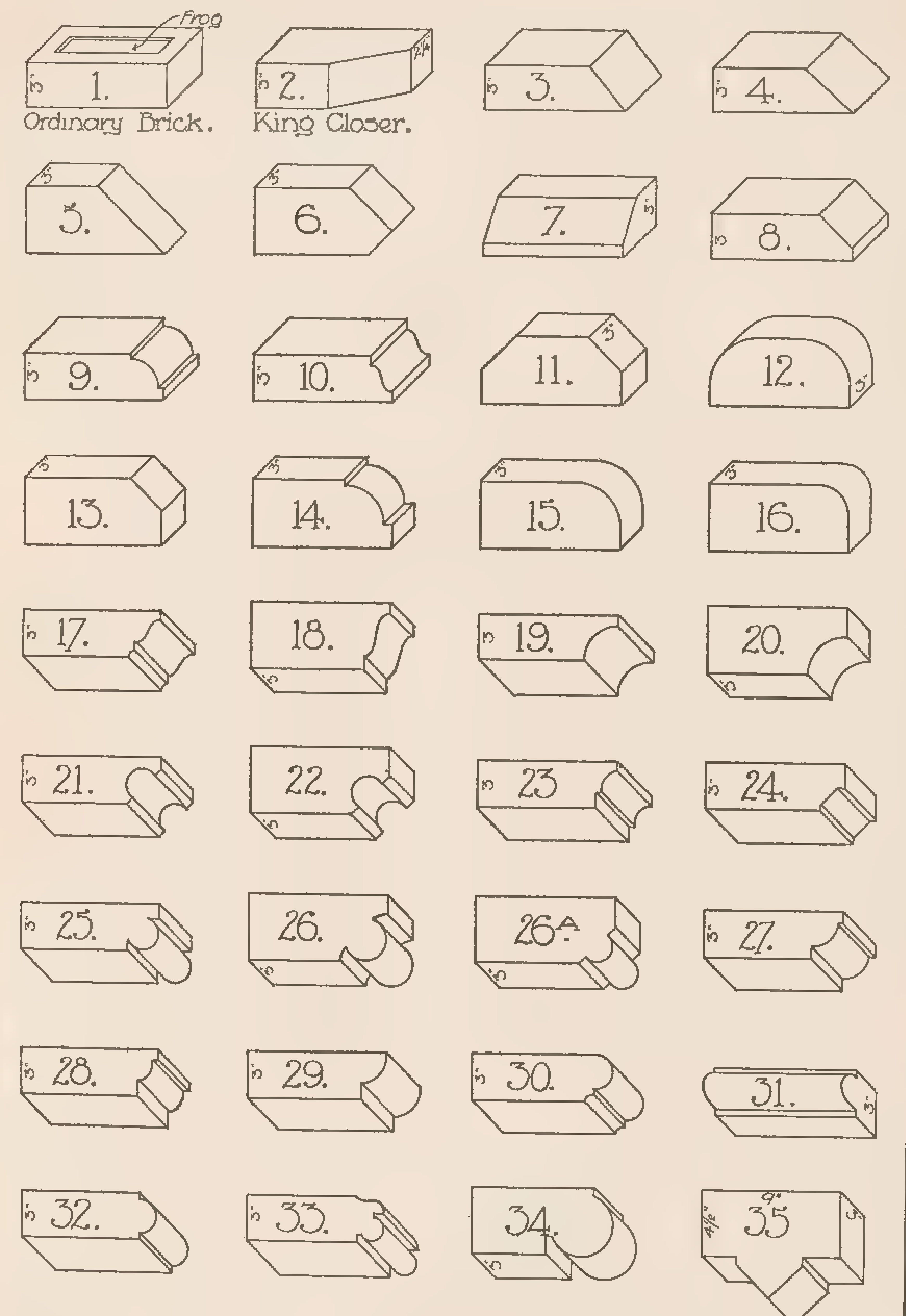
No. 33 is a hood mold, suitable to stand over door or window arches.

No. 34 is a form of brick used one on top of the other to form vertical columns.

No. 35, when built one upon the top of the other, forms a vertical V-shaped projection.

Stops and Returns.—In conjunction with these molded and

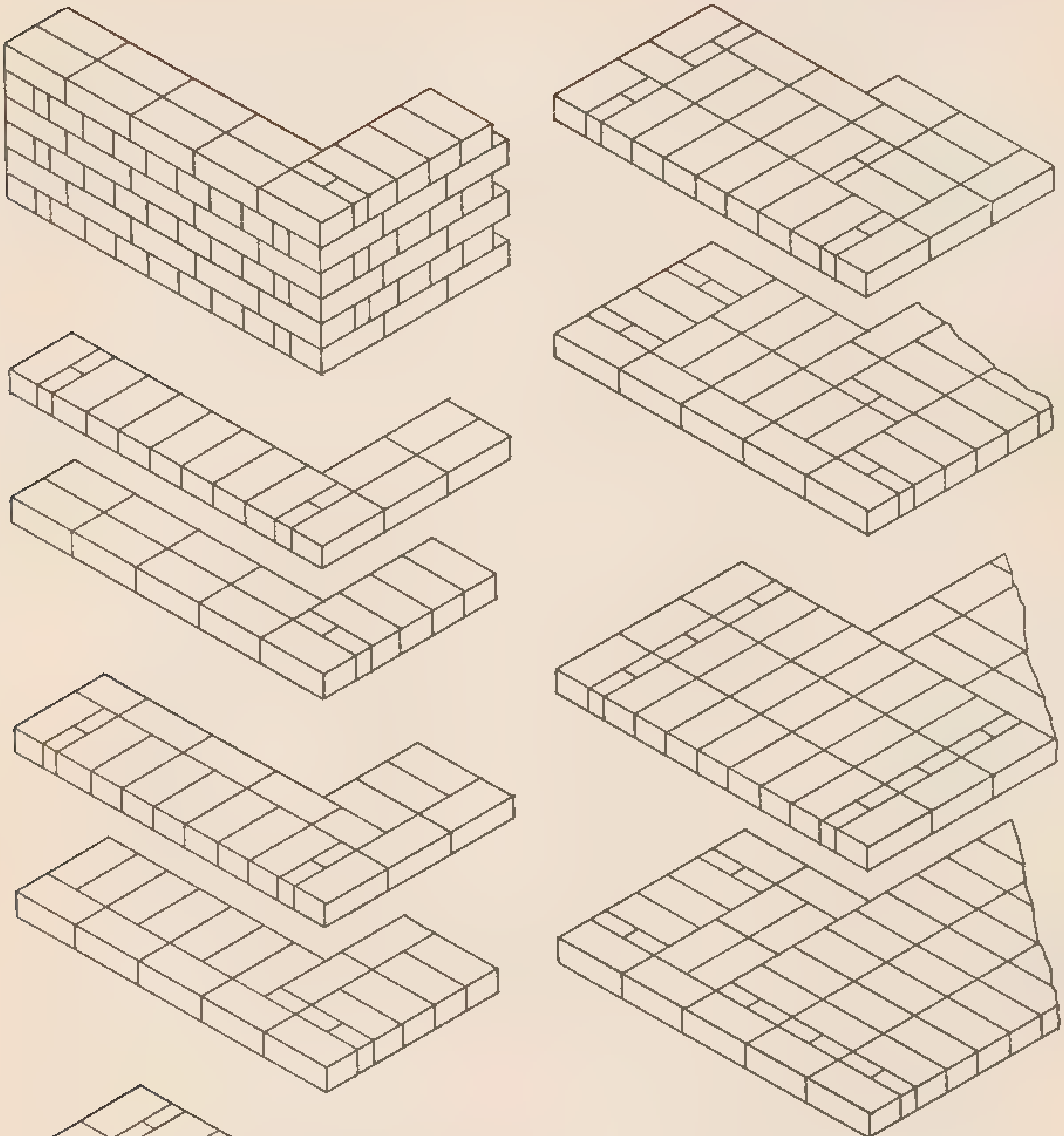
PLATE XLIII.

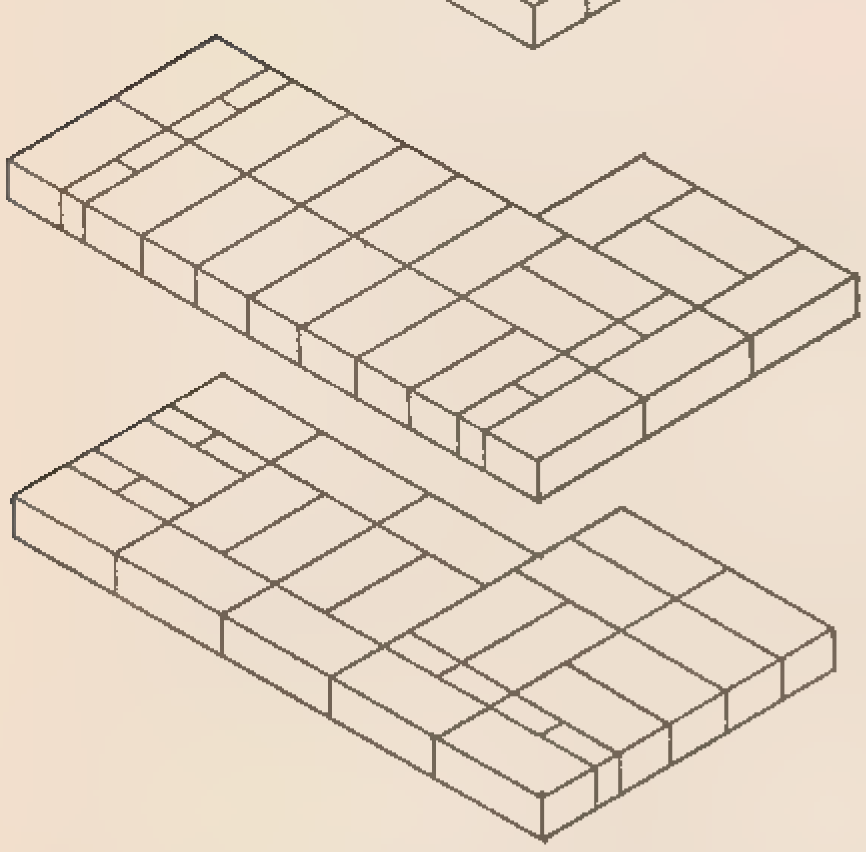


BRICKS OF VARIOUS KINDS.

The general over-all measurements of each brick are 9"×4½"×3" excepting only Brick No. 35.

PLATE XLIV.

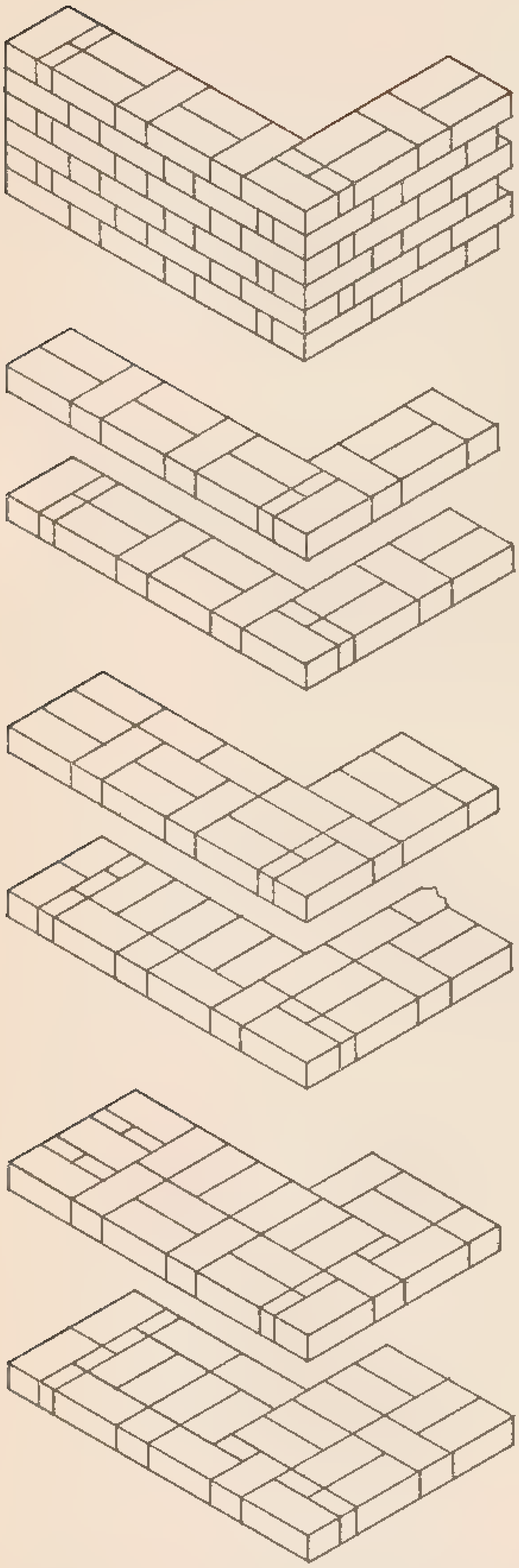


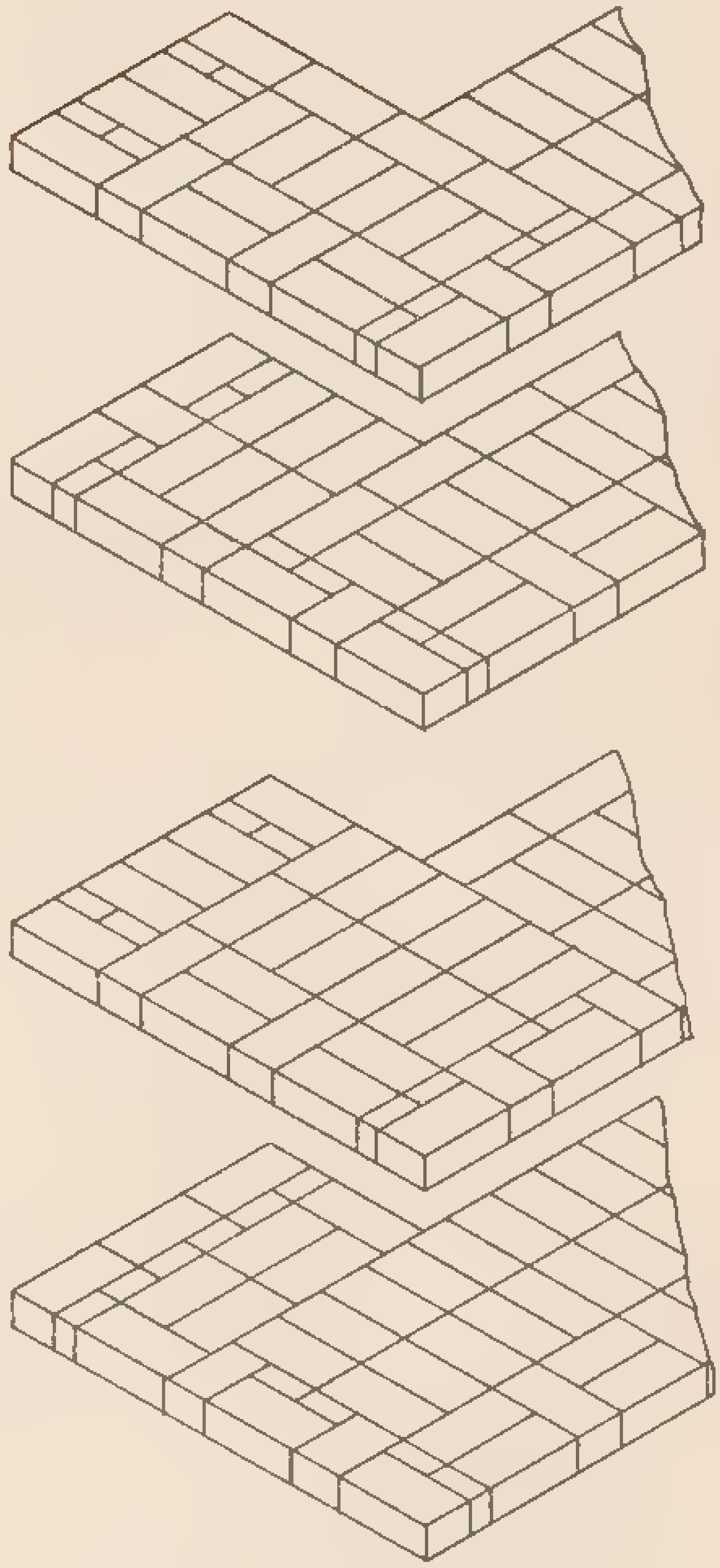


ISOMETRICAL PLANS SHOWING FIRST AND SECOND COURSES OF 1, 1½, 2, 2½ AND 3 BK. WALLS

.BRICKWORK IN ENGLISH BOND.

PLATE XLV.





ISOMETRICAL PLANS
SHOWING FIRST AND .
SECOND COURSES OF .
1, 1½, 2, 2½ AND 3 BK. WALLS
Note:- The One-Brick Wall.
is in Double Flemish Bond.

BRICKWORK IN FLEMISH BOND.

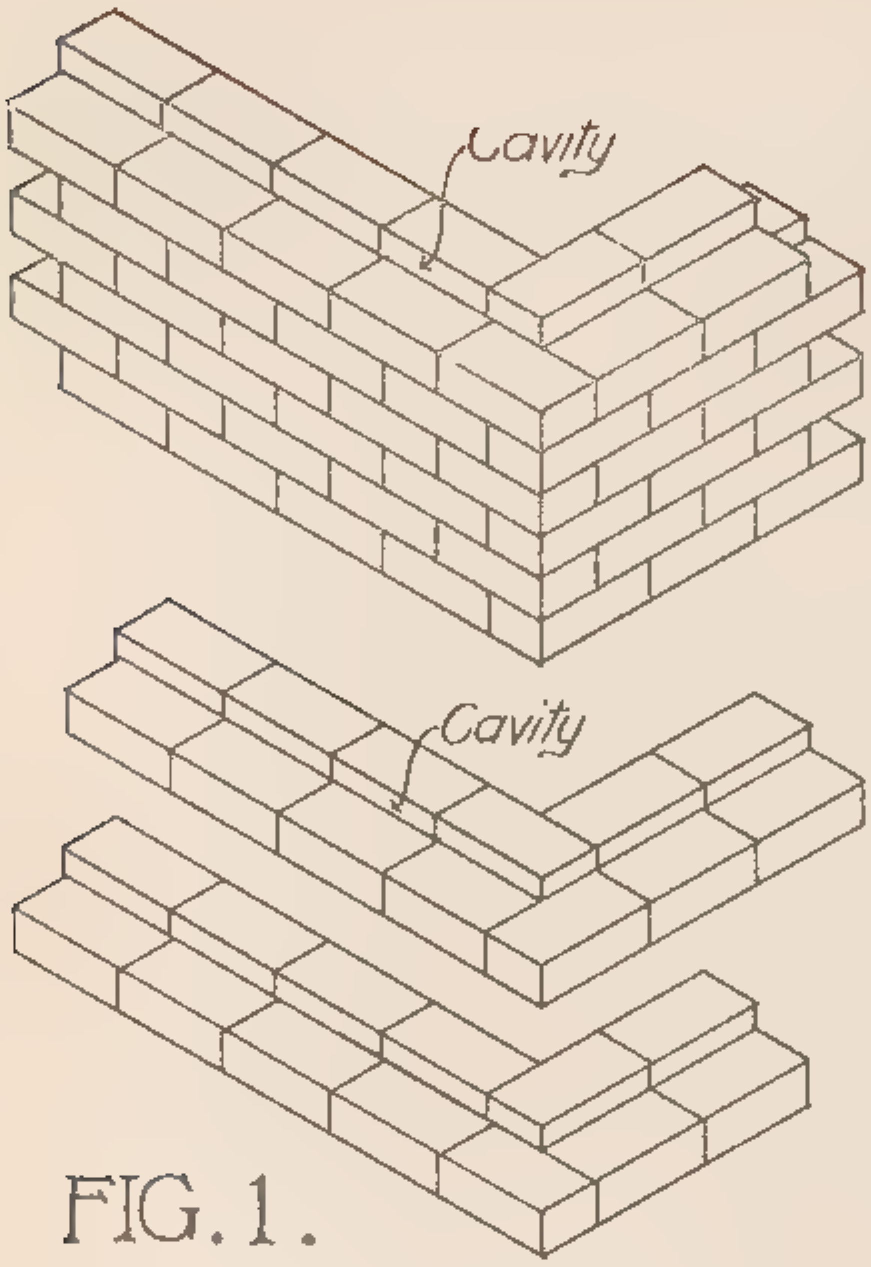


FIG. 1.

STRETCHER BOND.

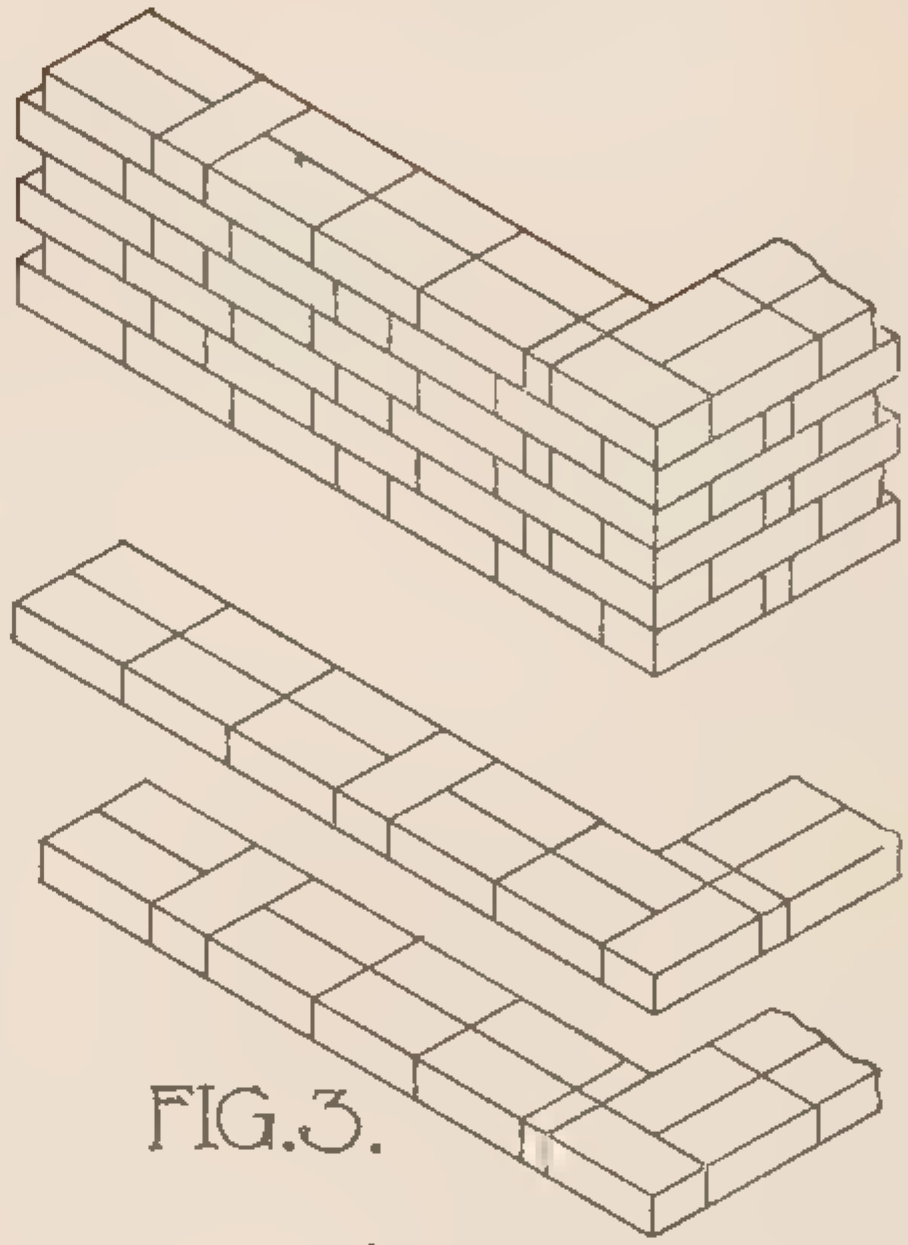


FIG. 3.

GARDEN WALL BOND.

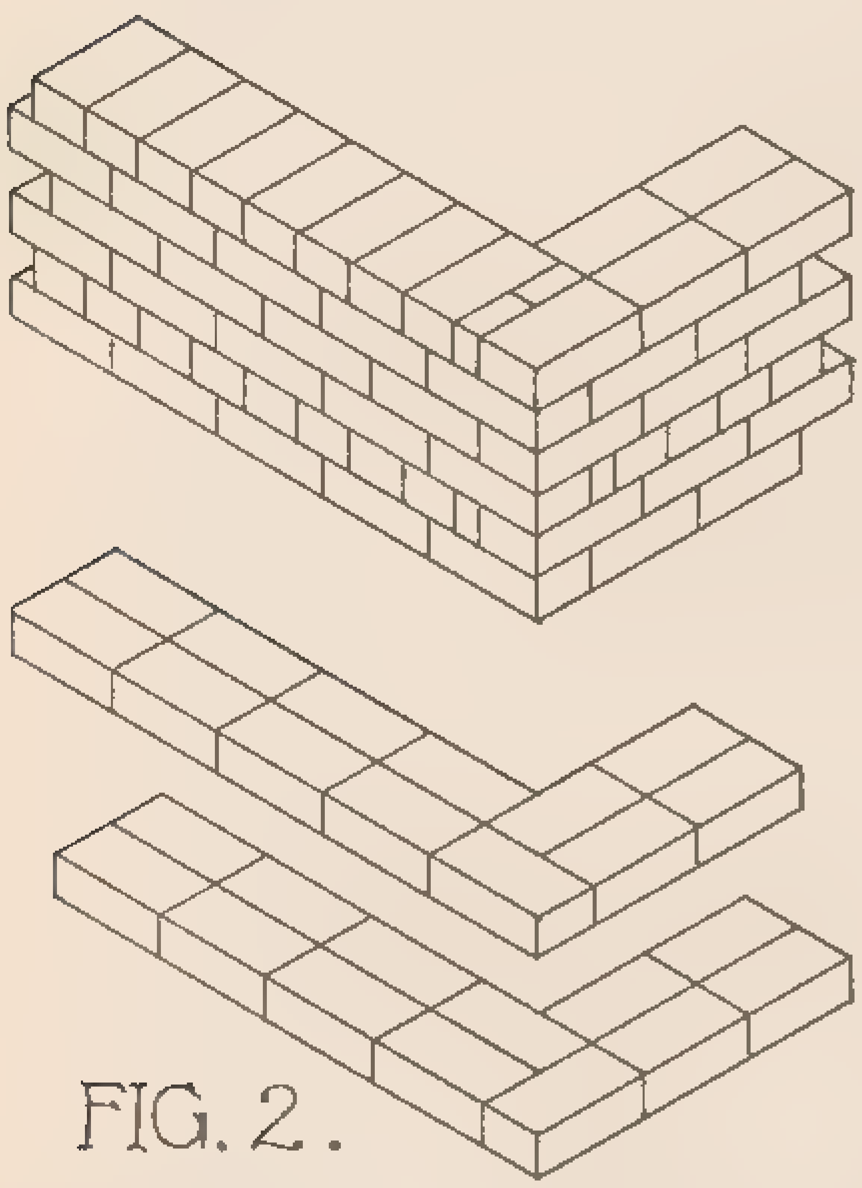


FIG. 2.

COLONIAL BOND.

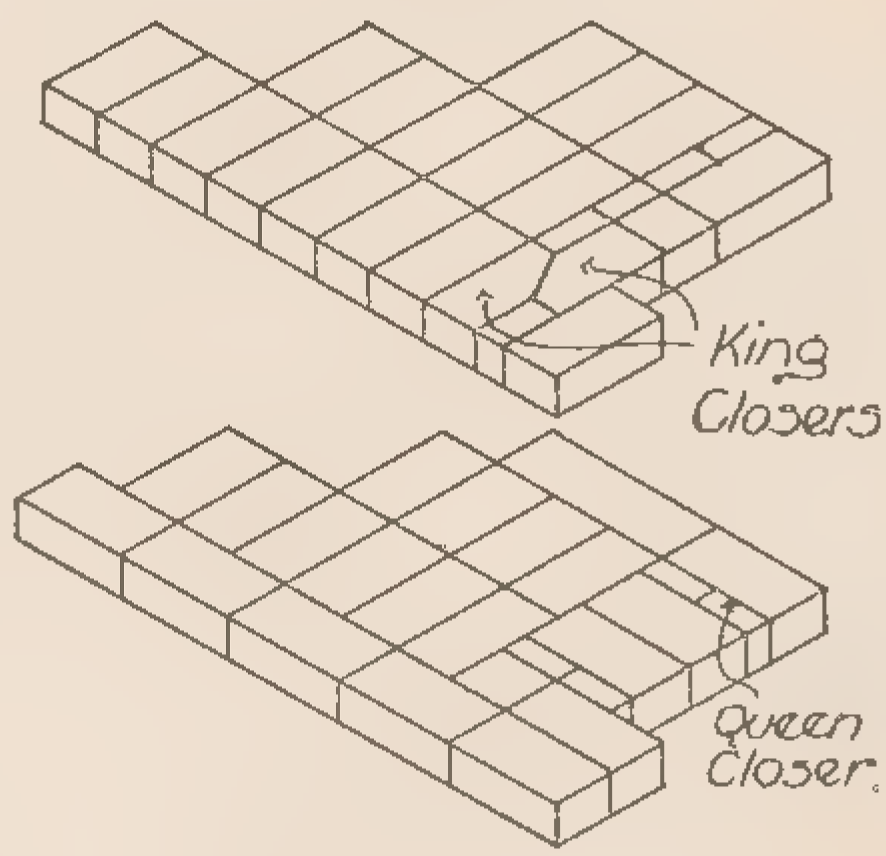


FIG. 4.

REVEAL IN THREE BRICK WALL.

special bricks, it is invariably necessary to use certain special made stops and internal and external angle bricks, which are made *en suite* to suit each type of molding.

Each brick also has its fellow "bonder," one being a "stretcher" and the other a "header," working together to break joint.

Mortars.—*Sand.*—The sand used in mortar must always be clean, sharp, and free from loam or salt.

Where the greatest strength is required cement mortar is used.

Cement Mortar should be compounded of one part of Portland cement to three parts of sand; this must be mixed dry, water added, and the mortar used fresh, as it sets quickly.

Lime Mortar should have one part of fresh-burnt lime, thoroughly slaked in a wooden mixing box, run through a fine sieve, and mixed with two and a half parts of sand, well knocked up, and left in large heaps fully ten days before use.

Technical Terms.—The following are common terms used in bricklaying:—

Course is a row of bricks laid horizontally.

Stretchers are bricks laid lengthwise to face of wall.

Headers are bricks laid endwise to face of wall.

Bats are portions of whole bricks.

Queen Closers are bricks 9 in. by 3 in. by 2¼ in. used to make bond (see Plate XLVI., fig. 4), usually in two pieces.

King Closers are bricks with one side cut to splay to form bond (see Plate XLVI., fig. 4).

Rough Cutting is used where bricks are required to be cut with the trowel, chisel, or brick hammer, for projections to take cement cornices, and in many other similar cases.

Gauging consists in cutting and rubbing to shape bricks for special purposes, such as in arches.

General Walling Methods.—In carrying up brickwork the following points should be carefully noted:—

Horizontals. –All work to be kept horizontally true.

Verticals.—All angles and faces truly vertical.

Work all over the building should be carried up, as far as possible, simultaneously. No portion of the work should be allowed to rise more than about 36 in. above any other portion of the work.

Wet Bricks.—All bricks should be charged with moisture before use. In dry weather bricks should be hosed or dipped in water, otherwise the dry nature of the brick will quickly absorb the moisture from the mortar and nullify its adhesive properties.

Frosty Weather.—No brickwork should be carried out in frosty weather. Tops of unfinished walls should be protected with boards from the action of frost. Frost acting upon mortar tends to expand the moisture in it and thus brings about disintegration of the particles, and consequent rottenness.

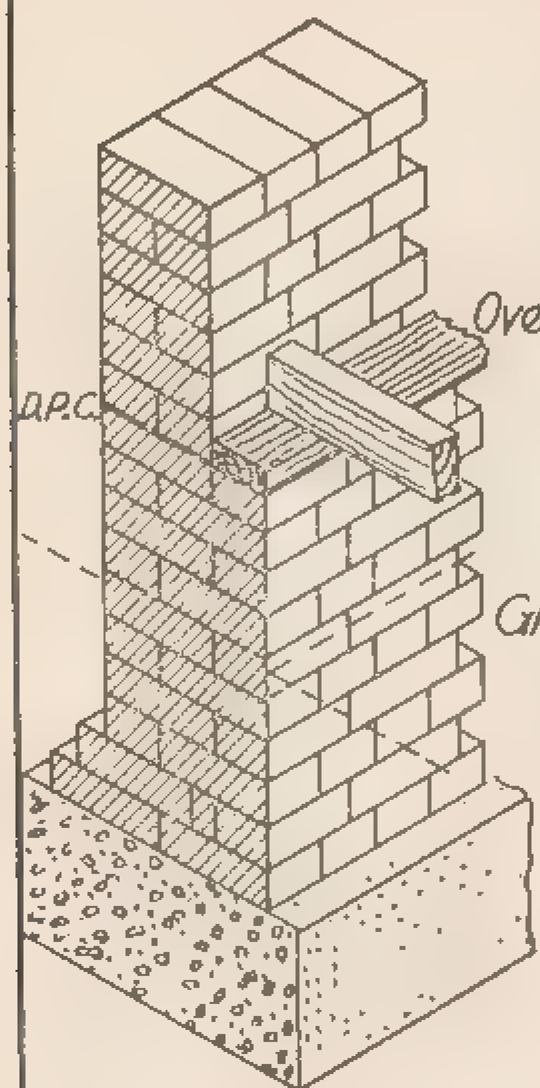
Hot Weather.—Excessive hot weather is bad for brickwork. The best conditions for good work are in winter, when the atmosphere is damp. The slow setting of the work is always to be aimed at.

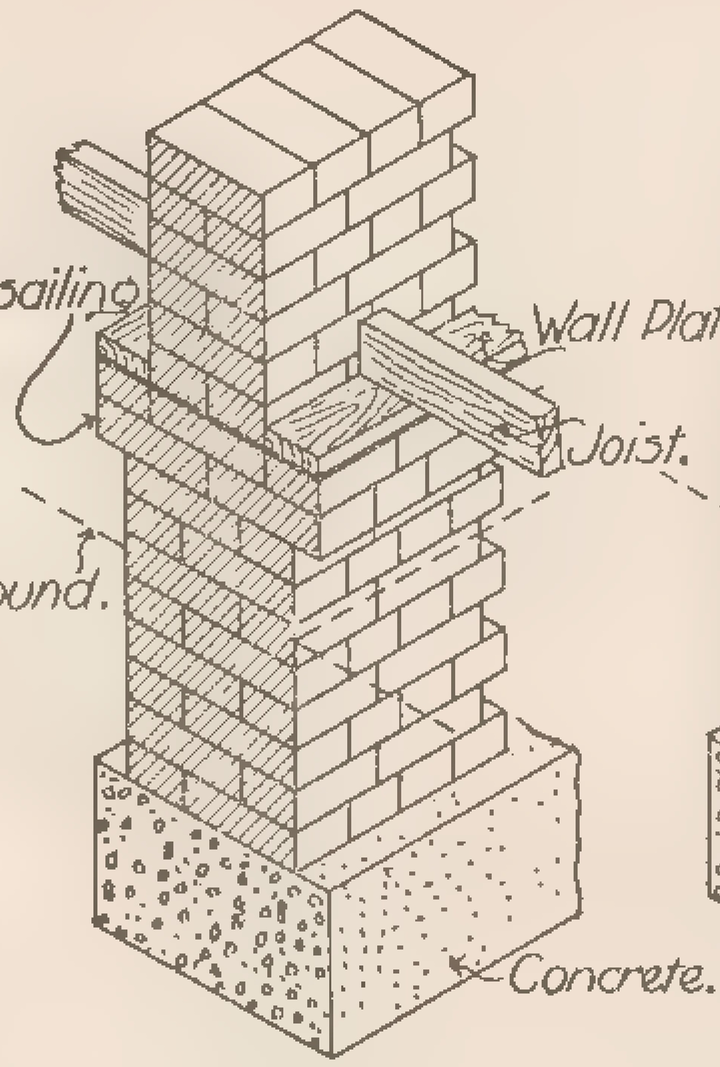
Bond.—Bond is the proper arrangement of bricks in walling. There are various kinds of bonding, some directed towards the securement of special strength, and others to show good face appearance.

For the purpose of learning how to bond brickwork the student would do well to obtain a set of wood model bricks, half full size. A good bond should avoid straight jointing—*i.e.*, one joint directly above the joint immediately below it. All bricks should, as far as possible, break bond—*i.e.*, lap one over the other.

The bonds in general use are five in number—viz., English, Flemish, Stretcher, Colonial, and Garden Wall bonds. They are illustrated on Plates XLIV., XLV., and XLVI.

English Bond consists of one course of stretchers and one course of headers. This bond is shown on Plate XLIV. The walls here





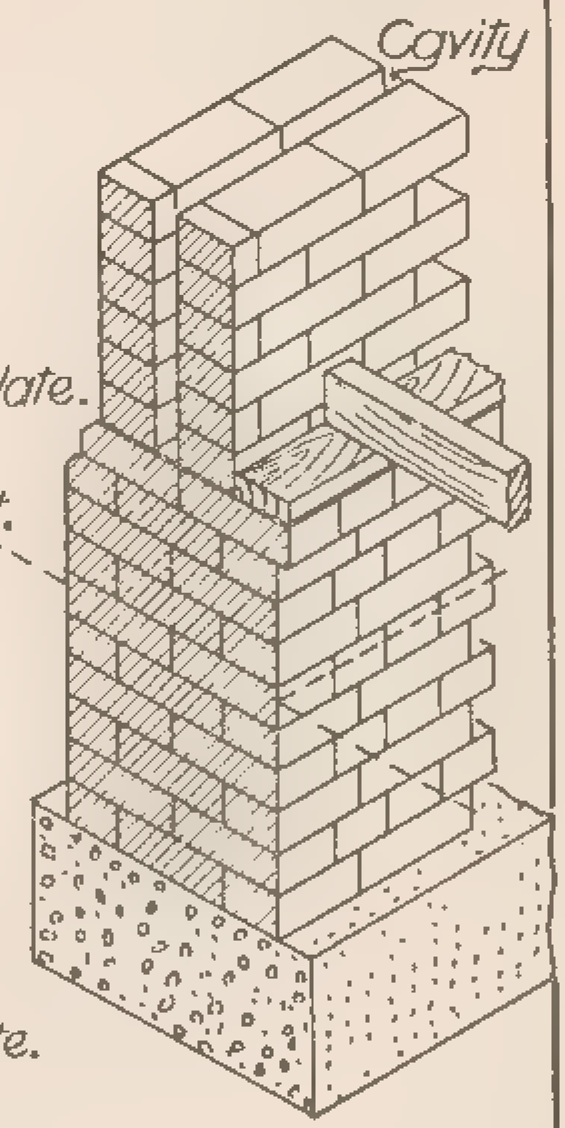
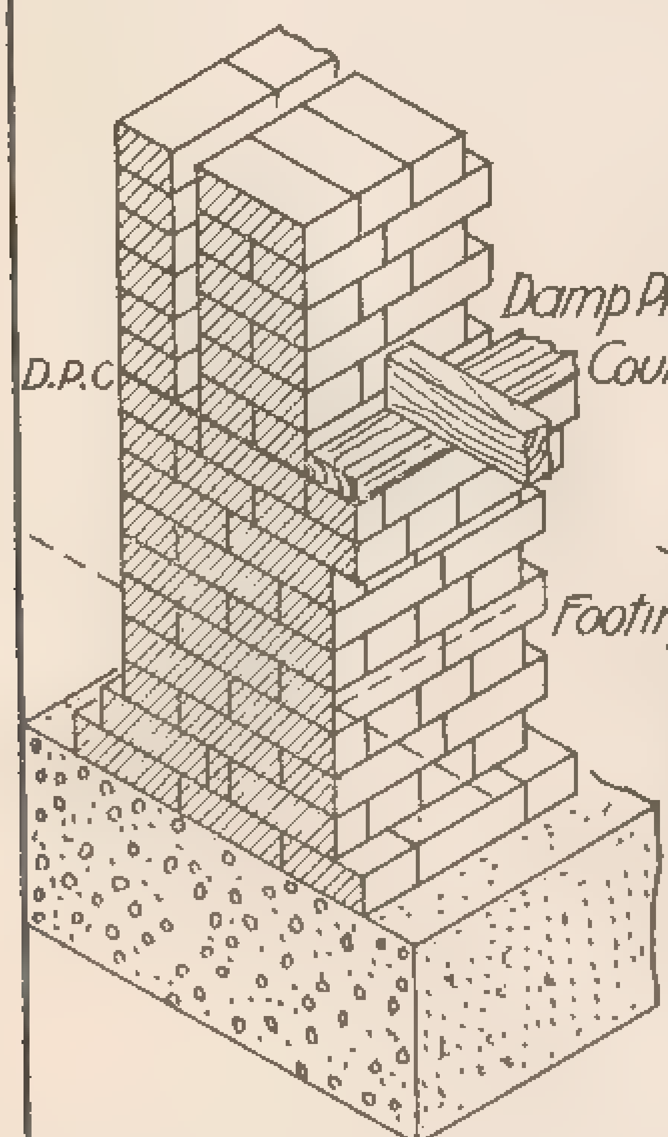


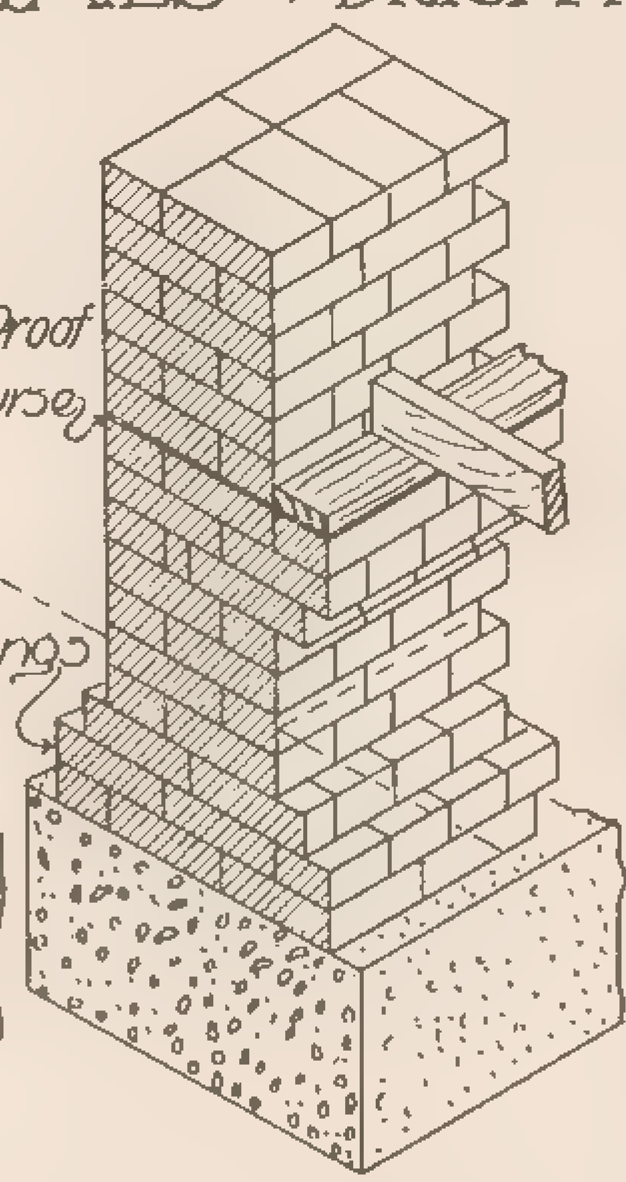
FIG. 1. 9in. External Wall.

FIG. 2. 9in. Internal Wall.

FIG. 3. 11" Hollow Wall with Plinth.

SECTIONAL DETAILS OF BRICK FOUNDATIONS





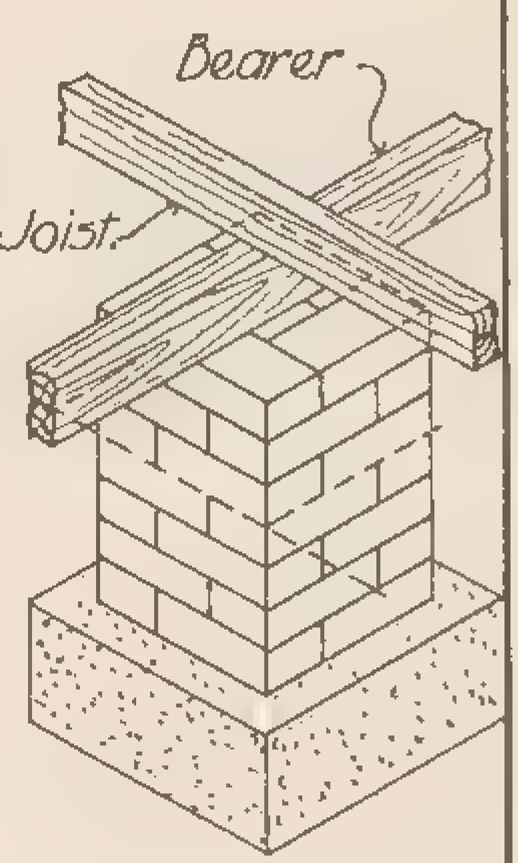


FIG. 4. 16" Hollow External Wall.

FIG. 5. 14" External Wall.

FIG. 6. 14"×14" Sleeper Pier.

PLATE XLVIII.

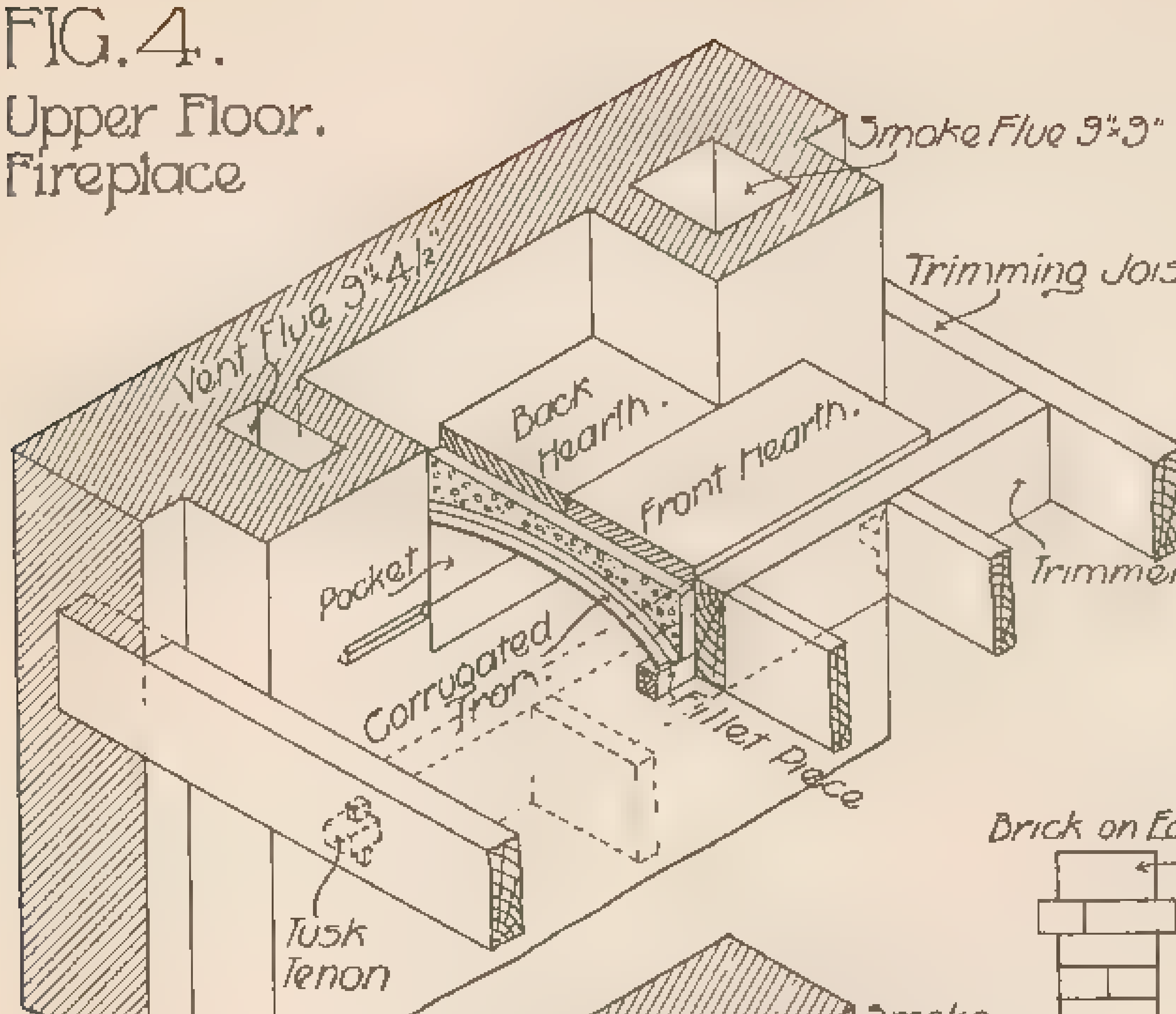


FIG. 4. Upper Floor. Fireplace

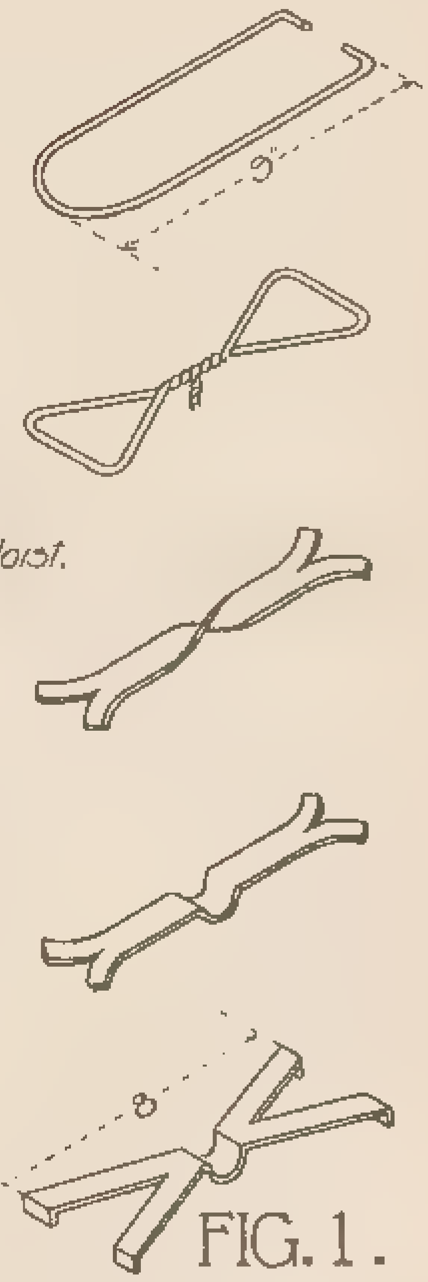
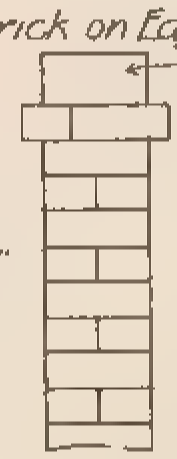
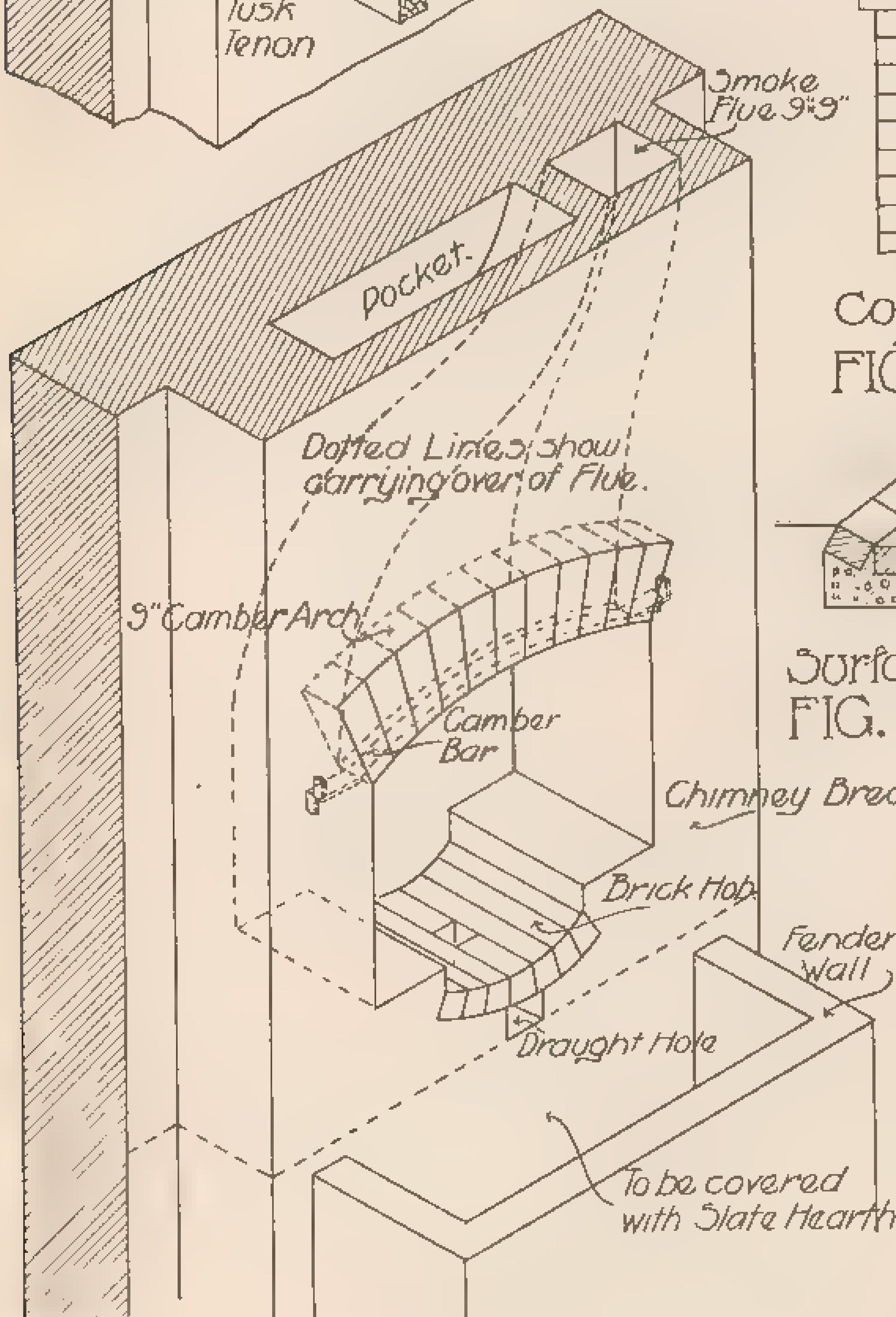
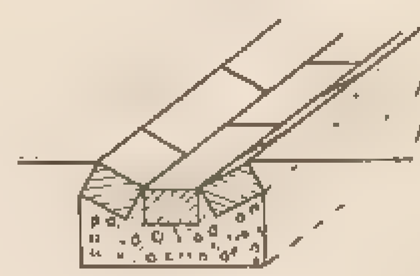


FIG. 1. Various Wall Ties.



Coping FIG. 5.





Surface Drain FIG. 6.

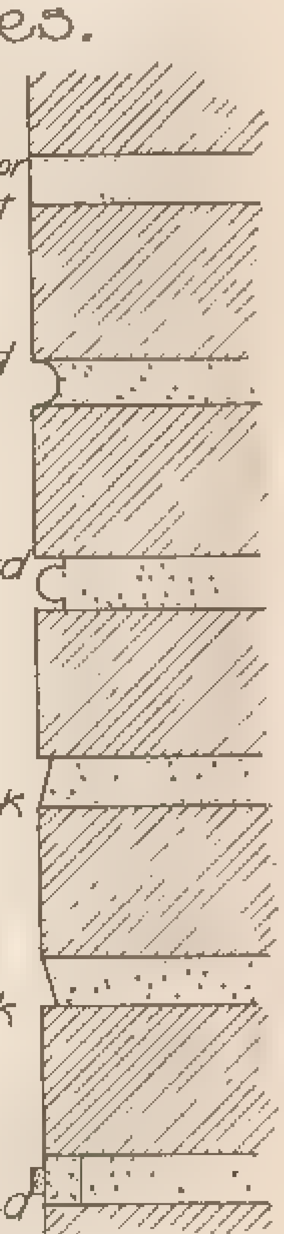


FIG. 2. Various Joints in Brickwork.

FIG. 3. Ground Floor Fireplace.

drawn are from one to three bricks in thickness, each showing an external angle, called a quoin, and a fair stop end.

Flemish Bond has one stretcher and one header alternating upon the face in each course.

In walls exceeding one brick in thickness the usual custom is to build the internal faces in English bond. This is shown in Plate XLV.

Where double Flemish bond is required—*i.e.*, same appearance on both faces, this may be secured by repeats. It will be seen, however, that in the case of brick and a half work, considerable cutting has to be resorted to.

This bond gives a pleasing face appearance, and is specially suited to the use of superior facing bricks.

Stretcher Bond is that which is used in any kind of half-brick walling. This bond consists solely of stretchers laid to break joint in each course. (Plate XLVI., fig. 1.)

Colonial Bond is an arrangement of three courses of stretchers and one course of headers. In this walling care should be taken to arrange half bond in centre course of stretchers. (Plate XLVI., fig. 2.)

This bond shows elements of constructive weakness when applied to thick walls, the number of internal straight joints being excessive.

Garden Wall Bond is often applied in one brick thick walling where joints are struck on both faces. It consists of three stretchers and one header in each course (see Plate XLVI., fig. 3).

Hoop-iron Bond.—Walling may be strengthened by the inlaying of hoop-iron bond. This is best done with long lengths of 1 in. wide 18 B.W. gauge, galvanized hoop iron, laid one strand to each half-brick in the thickness of the walls, for two or three courses, at heights of about 6 ft. The strands should continue for full length of walls and be turned up and down at ends and crossed and laced at angles.

Bar-iron Bond.—Where foundations are inclined to be unstable, the brickwork, especially in foundations or over openings, may be tied together with bond iron, laid the same as hoop iron, consisting of 3-in. by $\frac{3}{8}$-in. flats and ditto. These would, however, be laid in single courses only, one row to each half-brick of thickness of the walls.

Hollow Walls.—External walls, wherever possible, are best built hollow. This method ensures dryness in the internal faces, and tends generally to equalize the internal temperature of the building.

In party walls between adjoining owners, *Building Acts* often forbid this method, with the result that, where such walls are exposed to driving rains, serious saturation may take place, unless the outside faces are specially coated or protected.

Hollow walls are generally built solid at their foundations, up to the underside of the ground floor plate, where they divide into two distinct thicknesses, either equally or unequally, a cavity of from $1\frac{1}{2}$ in. to $2\frac{1}{4}$ in. being left between. See Plate XLVII., figs. 3 and 4.

As a general rule, should the thickness of the wall as a whole consist of more than two half-bricks, the greater thickness is best kept upon the inside of the work, so as to take the weight of floors, &c.

The two thicknesses of a hollow wall are bonded together with ties. These generally consist of galvanized wire bent to shapes, or of wrought or cast galvanized iron ties, some examples of which are shown on Plate XLVIII., fig. 1.

These ties are laid at right angles across the cavity at distances of about 30 in. apart in every fourth course diagonally. Care should be taken to keep the cavity and ties free from falling mortar as the work proceeds.

Jointing.—The thickness of jointing in brickwork depends, in a measure, upon the kind of bonds used, the coarseness of sand in the mortar, and the class of work.

For general walling a $\frac{3}{8}$-in. thick bed joint may be taken as satisfactory.

External joints may be left fair after plastering, or finished in various ways for visible faces, such as struck, struck and cut, ruled cut and struck, down struck and cut, beaded, keyed, or tuck-pointed, as shown in Plate XLVIII., fig. 2.

Footings.—Footings are the first courses at the base of a wall. They should be spread out wider than the general walling, so as to increase the area of bearing.

No definite rule can be laid down for the spread of footings, but a safe rule is to allow one course projecting $2\frac{1}{4}$ in. on either side of the wall for every half-brick of its thickness. This usually secures a spread of double the width of the wall, whatever its thickness may be.

Considerations of base courses, wall plate offsets, &c. (see Plate XLVII.), will in many cases alter this rule.

Damp Courses.—All brick walls, being of an absorbent nature, are liable to gather moisture from the soil, which, rising in the wall, leads to saturation of plaster, floor timbers, &c. This has to be guarded against. Damp courses are therefore inserted through the full thickness of all walls just above the ground level.

In the case where the wooden ground floor is at a normal level above the ground, the underside level of wall plate (see the various figures on Plate XLVII.) offers a suitable position for the damp course.

A damp course is a layer of impervious material, and may consist of any of the following :—

Hot tar and sand spread $\frac{3}{4}$-in. thick.

Roofing slates set and bedded in cement.

Mineral asphalt.

Felt, various patent manufactured damp course materials, sheet lead, or hollow vitrified stoneware.

In hollow walls a good rule is to introduce a second damp course

through the inner lining of the wall, to prevent any moisture rising from the bottom of the cavity.

PROJECTIONS.—*Oversailings.*—Projections in brickwork are of various kinds. The simplest is fair oversailing—that is, one course slightly projecting or standing over the next course immediately below it.

Corbelling Out is another term applied generally to roughly-cut projections.

In cement cornices, string courses, chimney caps, and in many other positions rough corbelling is used, supplemented, in the case of very wide projections, with slate or stone cores to carry overhangs too great for brickwork.

Projections, such as oriel windows, are often carried out upon concrete tied back into the brickwork.

OPENINGS.—Doorways and window spaces are generally referred to in the trade as "openings," the outside vertical faces being called "reveals"—*i.e.*, the parts seen; and the inside vertical building the "jamb," generally occupied by the frame and wooden jamb lining (see Plate XLVI., fig. 4).

LINTELS.—Openings are bridged over at the top by lintels or arches. A lintel is a horizontal beam, generally of stone, but sometimes of concrete, used to carry the weight above the opening. Where steel is used the beam is generally spoken of as a "girder."

ARCHES.—The arch is the most common device used for bridging openings. The work of the arch is to receive the weight above the opening, and to transmit it to the side piers. This a true arch does by its wedge-like character of transmitting the weight from voussoir to voussoir, and so finally to the haunch or solid bearing point (see Plate XLIX., fig. 2).

This figure clearly shows the technical terms for the various parts of an arch.

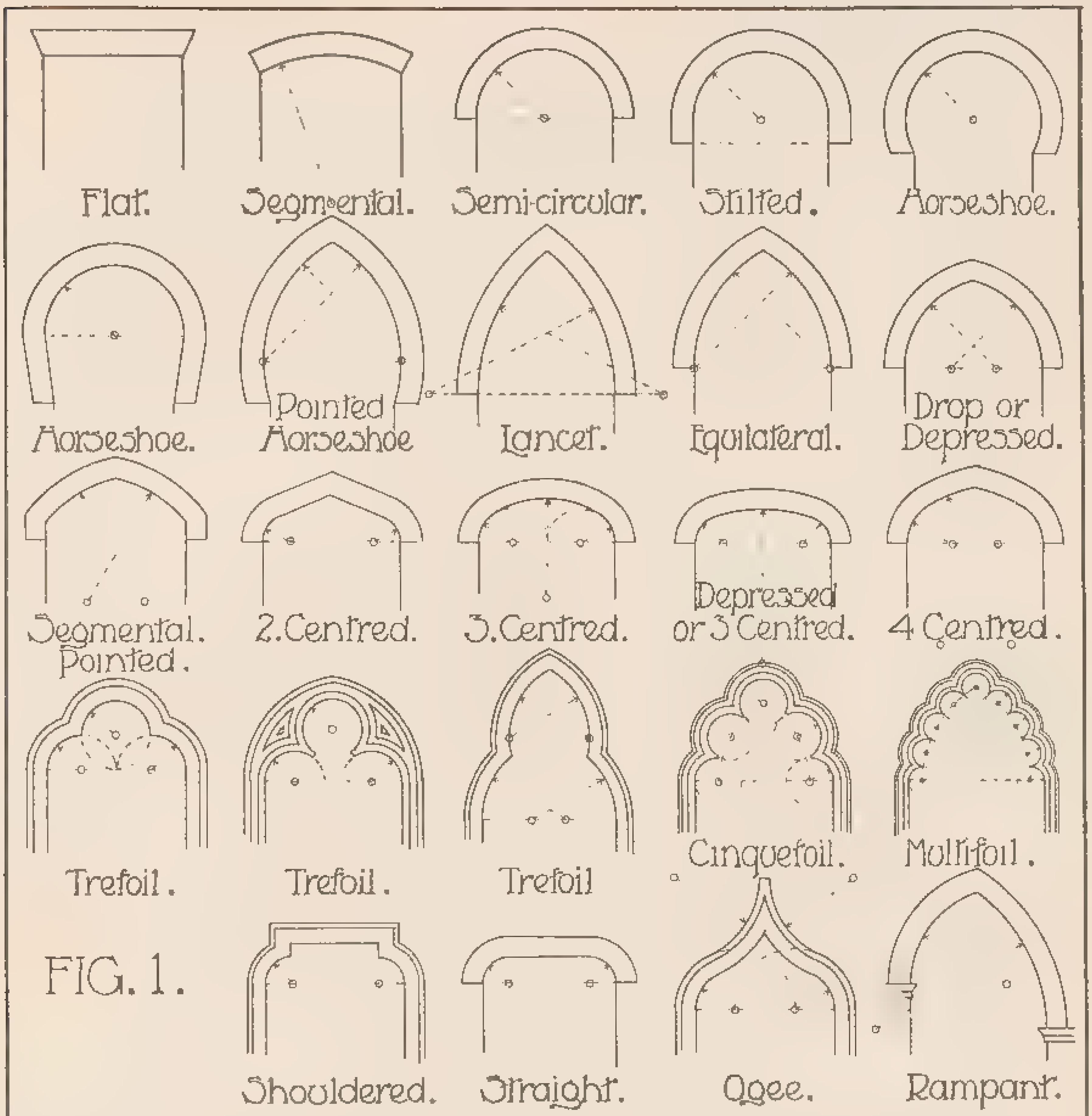


FIG. 1.

DIAGRAM SHOWING THE VARIOUS ARCH FORMS

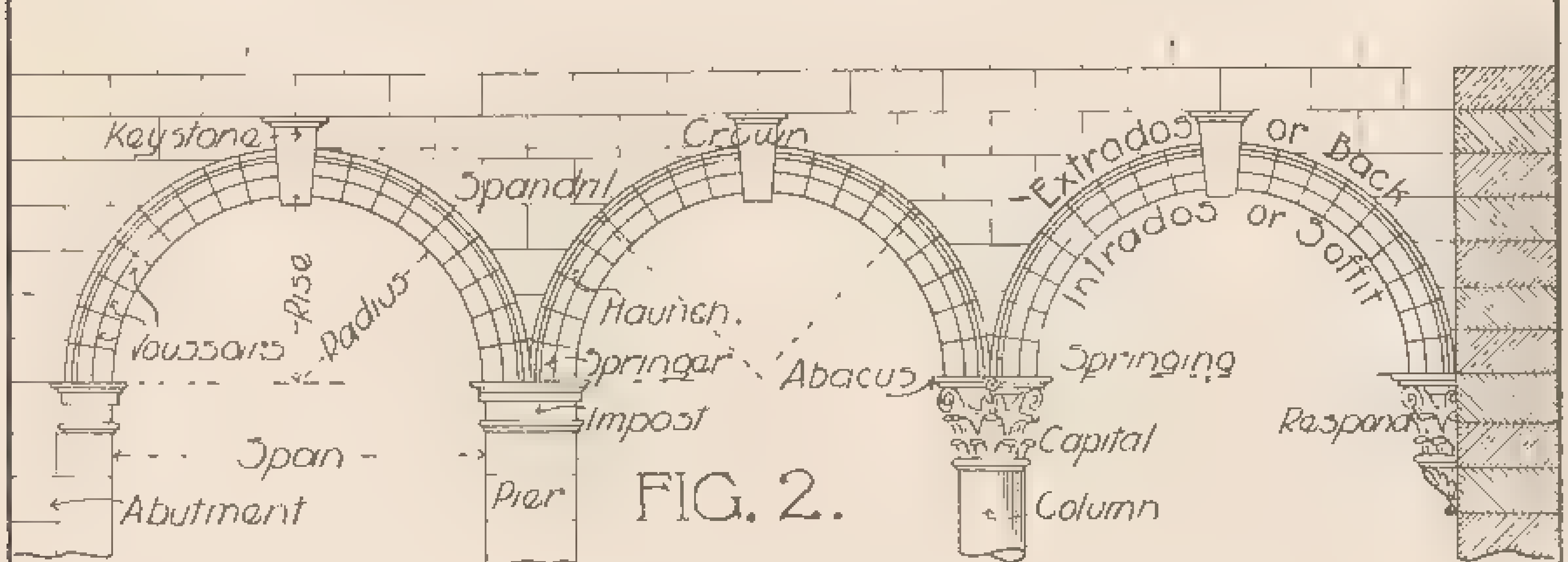
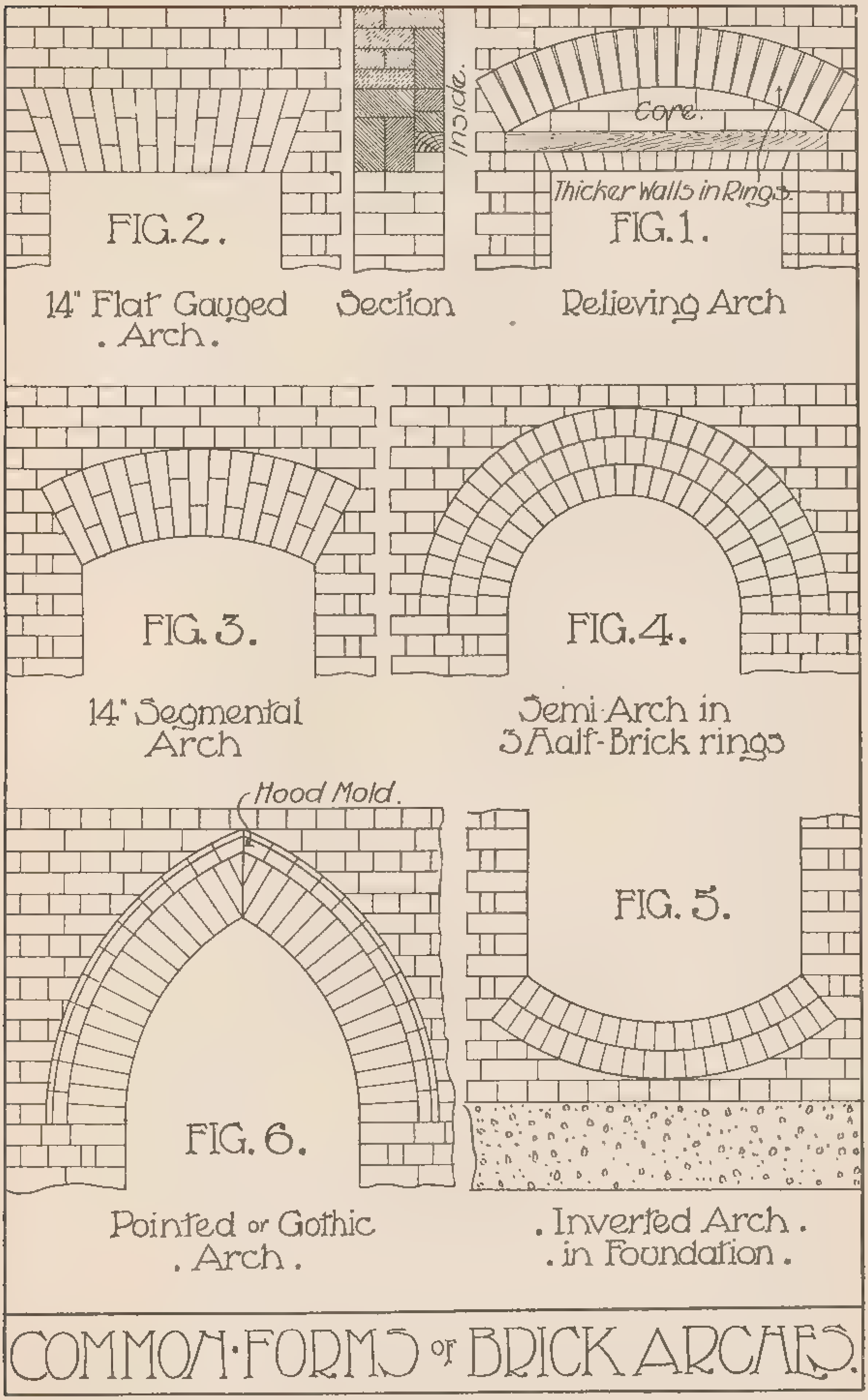


FIG. 2.

DIAGRAM ILLUSTRATING VARIOUS TECHNICAL TERMS APPLIED TO ARCHES ETC.


Inside.
Core.
Thicker Walls in Rings.
FIG. 2.
FIG. 1.
14" Flat Gauged . Arch.
Section
Relieving Arch
FIG. 3.
FIG. 4.
14" Segmental Arch
Semi-Arch in 3 Half-Brick rings
Hood Mold.
FIG. 5.
FIG. 6.
Pointed or Gothic . Arch.
. Inverted Arch . . in Foundation .
COMMON·FORMS of BRICK ARCHES.

Arches are of various kinds according to the work required of them. Arch forms have also been greatly influenced by various styles of architecture.

Plate XLIX., fig. 1, shows the various basic forms of the arch, their names, and the manner of their setting out.

Brick arches are either "rough" or "gauged." A rough arch may be formed of uncut bricks set to radiate, or the bricks may be roughly cut. When all the bricks are cut and rubbed and all joints are of the same thickness it is called a gauged arch.

Plate L. shows the various kinds of brick arches in common use.

Fig. 1 shows a simple, rough, internal relieving arch, designed to bridge over and relieve the wood lintel of a door or window opening. Fig. 2 shows a flat gauged arch, such as would be used over an external door or window, and in front of fig. 1 as shown in the section.

Fig. 3 is another gauged arch, the rise or camber being the segment of a circle. This form of arch is termed "a segmental arch."

Fig. 4 is a "semi-circular arch" built in three half-brick rings. This is a specially strong arch, and is used in heavy work.

Fig. 5 is an "invert." This is a form of arch applied in various ways to distribute the weight of walling or piers, as far as possible, over a common foundation.

Fig. 6 is a pointed Gothic arch in brickwork, with projecting hood mold over.

Arch Supports.—External flat or camber arches to openings up to about 4 ft. span may be carried on wrought-iron bars shaped to the rise of the arch, which is called a "camber." The bar varies with the work required of it, but for an ordinary 3 ft. opening and $4\frac{1}{2}$ in. thick face arch, a $2\frac{1}{2}$ in. by $\frac{3}{8}$-in. flat iron camber bar, built in and turned down at ends into the work, is sufficient.

Other arches require temporary wood centering to support them. This is struck away when arches have set.

Sills.—Brick sills are not recommended for weather tightness in the same degree as stone sills (see Masonry).

Where brick is used the top requires to be cemented, and an upstanding iron bar or cement rebate formed for wood sill to sit over.

Where stone is used, it is set by the bricklayer at the ends only, the joint underneath being left free, and pointed up at completion of the work, otherwise the danger of slightly unequal settlement in the wall may fracture the sill through its centre.

Fire-places.—The normal fire-place is built as Plate XLVIII., fig. 3, the various technical terms being here given. The size and finish of opening depends entirely upon circumstances.

Fire-place openings are of four kinds :—Open hearths, where the opening is built fair and the fire is contained within detached iron fire grates; brick hobs for holding wood; openings where grates are built in; large openings fitted with range or stove.

On first or upper floors the general work around a fire-place depends upon the number of flues (if any) from below. The hearth also has to be carried. This latter may be done in two ways, either by building a trimmer arch, or by nailing cleats to the sides of the floor joists, bridging with galvanized corrugated iron, and filling in with concrete to carry a tile or slate finish (see Plate XLVIII., fig. 4).

Smoke flues from the lower floors pass up at the sides of upper fire-places, and are contained in the chimney-breasts. In this way the whole of the flues of each group of fire-places, whether one below the other or back to back from adjoining apartments, are gradually gathered together, and terminated in the chimney.

Smoke Flues.—Each fire-place must have its own separate smoke flue, which should be skilfully gathered over with a bend to one side to check down draught—9 in. by 9 in. inside size is generally sufficient for ordinary fire-places, and 14 in. by 9 in. for kitchen flues.

Smoke flues require to be pargeted—*i.e.*, rendered smooth inside with a tough coating to catch and hold soot. This is best made with a mixture of brickdust, lime, and cowdung.

Vent Flues.—The bricklayer is required to build in and form various vent flues. The simplest forms consist of wall faces of perforated terra-cotta or galvanized cast iron 9 in. by 6 in. or 9 in. by 3 in., built into the work fair with outside faces. A smooth, cement rendered, upsloping cavity passing through the wall acts as an air duct.

Such vents are used for ventilating under wooden ground floors, near the ceilings of rooms, &c.

Vertical flues carried up in the walls may be built like smoke flues, smoothly rendered inside in cement; or galvanized sheet iron round piping may be built into the work for this purpose.

Chimneys.—Smoke flues are terminated in chimney stacks. These should contain the flue, or flues, grouped in such a way as to suit best the external appearance of the building, and so upstanding as to be carried high enough above all adjoining roofs to prevent down draughts.

The brick divisions between flues are generally a half-brick in thickness; this, in case of high, wind-swept stacks is best increased on certain sides.

A chimney is generally treated in some more or less ornamental way with breaks, molds, &c., to which terra-cotta pots may well be added if the locality be subject to high winds, for pots, if well made, tend to counteract the danger of down draughts.

Building In.—The bricklayer in the course of his work has to build in frames, thresholds, sills, templets, cores, guides, fixing bricks, lintels, &c.

In hollow walls frames are best secured by having cleats nailed on the sides fitting into the cavity.

In solid walls frames are secured by 1-in. by $\frac{3}{8}$-in. galvanized

wrought-iron clips, clasping over the top of the frames and the outside face of the brickwork, or by built-in galvanized hoop iron, nailed to the sides.

Stone thresholds, sills, and templets are best set in cement mortar.

Brickwork and Stone Dressings.—Buildings classed as brick buildings are seldom entirely complete without the addition of stone or cement dressings, and the mason's or plasterer's work has to be allowed for side by side with the brickwork.

Dressed stone is of all forms of building generally found to be the most expensive, and its use is therefore in many cases limited and confined to what are technically known as "dressings"—such parts as sills, quoins, columns, copings, and the like.

Another class of building prevails where rough stone is abundant and stone for fine working is scarce or too expensive. In this case the order is at times reversed, the special finishing parts such as sills, arches, quoins, &c., being built in brickwork.

Brickwork is also largely used as a backing for stone walls.

Brickwork and Cement Dressings.—For the purpose of giving extra imperviousness to brickwork, or for changing its general external character, walls may be stuccoed (see Plasterer). In this class of work the joints are left rough, in the same way as for internal plastering.

Where cement dressings, flush bands, or surface rough-casting is to be done, the work so to be treated requires generally to be set in three-quarters of an inch.

Cement moldings are carried out in brick, stone, or slate oversailings and rough-cut projections, and have to be allowed for in bricklaying, as also do the various pressed cement or ornamental features that may be a final part of the design.

Copings.—Copings are the top finishings of external exposed

walls, such as parapets, gable ends, &c., where they require to be protected against the down-soaking of rain-water.

Copings are often of stone, but may be of simple hard cement top surface weathering, or the brickwork may be finished with oversailing brickwork, rendered in cement.

Sometimes the finishing course is set with specially hard bricks on edge in cement, the second course being slightly oversailed on either side, as shown in Plate XLVIII., fig. 5.

Pointing.—The joints of visible face brickwork may be finished in different ways as the work proceeds (see Jointing), or pointed down after. Pointing may consist of ordinary pointing or tuck-pointing.

In ordinary pointing the joints are first raked out and afterwards stopped-in with cement or specially colored mortar, and finished by any of the methods before mentioned.

In tuck-pointing the brickwork is generally colored first, the joints being stopped-in flush with colored mortar, upon which a raised putty joint is lined out.

The whole process savors of artificiality, and is not recommended for first-class work.

Open Brick Drains.—Surface drainage is often carried off by open brick drains. These should be of specially hard and impervious bricks set and jointed in cement mortar, centre bricks being laid to falls (generally about 1½ in. in 10 ft.), and the side bricks tilted towards centre. (Plate XLVIII., fig. 6.)

Such a drain may be bedded on sand, but in good work a 4-in. bed of cement concrete is best.

Where drain receives down pipes, wastes, &c., it is often necessary to build small brick enclosures with vertical sides. These are called sinks, or cesses.

Furnace Work.—Brickwork coming in contact with fire, as in furnaces, ovens, smoke stacks, and similar factory work, is best

carried out in bricks made of fire-clay, a material specially resistant to the damaging action of excessive heat, the joints being formed of fire-clay used as mortar.

If ordinary bricks be used, lime mortar and lime grouting should be employed, as cement does not so well withstand the direct action of fire.

CLEANING DOWN.—The final process in brickwork is to strike scaffold and "clean down." This is done by gradually withdrawing the scaffolding, brushing down the work, stopping and making good put-log holes, and washing down the visible faces with water. A wash of dilute muriatic acid may be employed to remove mortar or other stains from the bricks, but it should be used with care, as its action tends to cause the mortar to crumble. When the stain is moved the acid should be well washed off with a full supply of clean water.

Bricklayer's Memoranda.

Bricks are sold at per thousand.

Brickwork is measured by the rod, which consists of—

272 ft. super. 1½ bricks thick (this is standard work).
408 ft. super. 1 brick thick.
306 ft. cube.

A rod of ordinary brickwork contains about—

3,900 bricks.
1¼ yards of sand.
5 bags of lime.
Weighs about 15 tons.

CHAPTER XI.

MASONRY.

THE USE OF STONE.—Stone is an ideal building material, and, being a natural product found in most parts of the world, has been used from time immemorial in important buildings.

With the nature of the stone used the character of the work built has varied, and these factors have brought down from history endless interesting examples of work in this most classic of all crafts.

The nature, character, and suitability for use of natural stone varies considerably, and actual use, and the experience of time, are required to enable the designer to decide upon the most suitable and reliable stone for the work to be put in hand.

Cost of labor is always a considerable item in the working of stone, and this cost increasing in ratio with the size, the hardness of the material, and the completeness of finish put upon it, it will be found in practice that the best class of stonework is only used in the higher classes of building, and even then the most highly worked stones are reserved for the visible faces and special features or ornament.

The suitability of any stone depends in a very important degree upon the position the stone is required to occupy in the building, and the use required of it. For instance, a stone may make good general walling, yet may be unsuitable for steps, door thresholds, and the like. Or, on the other hand, a stone may be highly suitable, by its hardness and durability, for the latter work, and yet prove too expensive in the working, or too unyielding, for application in ornamental or molded features.

This phase of masonry has led to the division of work finish into

classes, from which has arisen most of the technical terms used in the craft.

Leaving aside the purely geological description of Australian rocks, the following may be taken as a practical division of our building stones, viz. :—Granite, trachyte, bluestone, ironstone, sandstone, limestone, marble, and slate.

Of these the denser kinds of sandstone and limestone, suitable for the best class of work, are referred to in the trade as "free-stones."

Effect of Weather.—In selecting building stone full consideration must be given to its suitability to withstand climatic conditions, for, though sound in the quarry, it may rapidly deteriorate when exposed to the impure air of cities or the effect of damp or frost.

In the short history of Australian building there are not wanting striking examples of grave deterioration in very highly finished stone buildings from such causes.

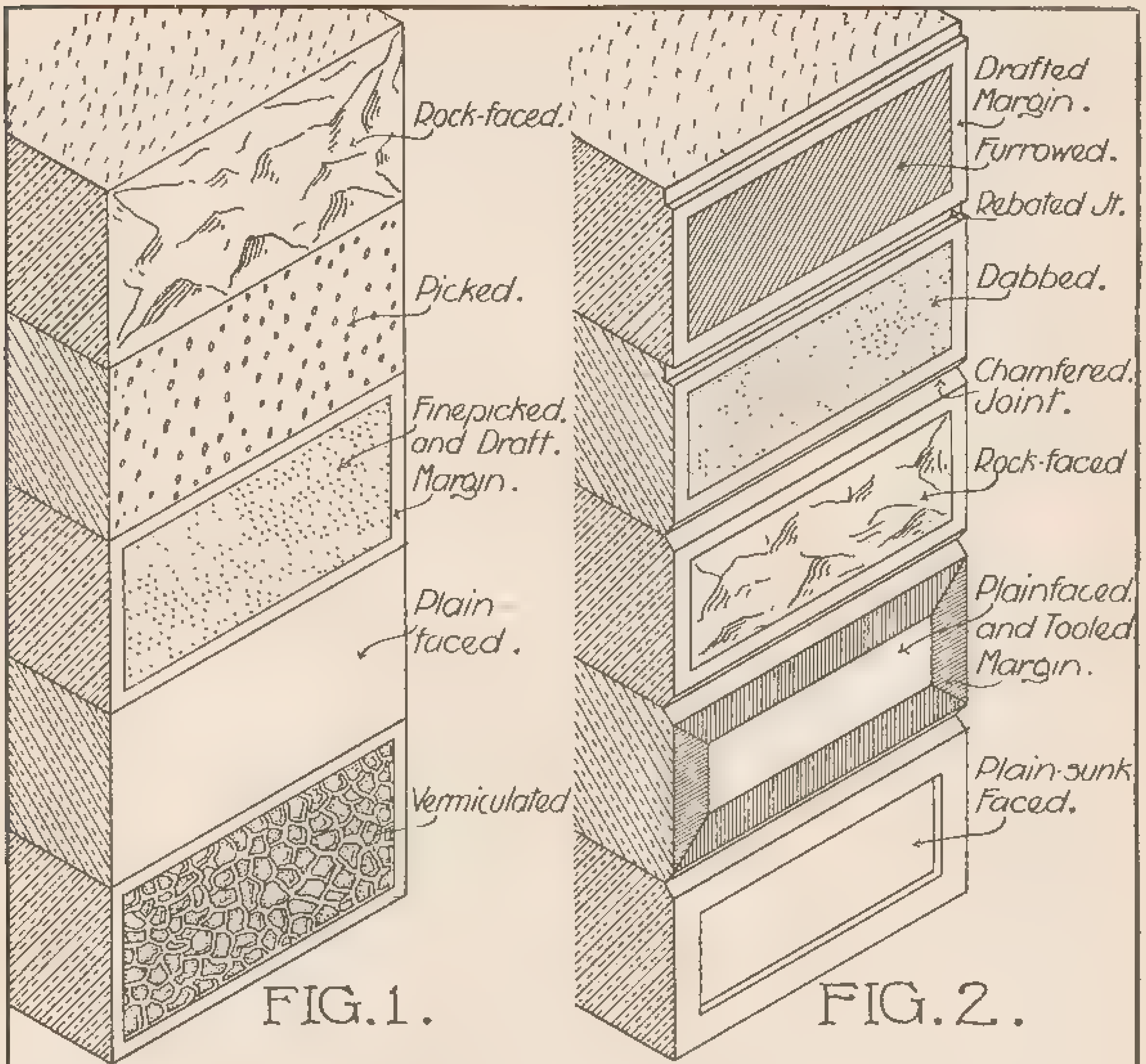
Some stones are really improved by exposure to the outer air, and harden up on the face upon being built in, while others quickly decay.

Natural Bed.—In stratified rock the natural bed is the first thing the mason looks for, for all stones should be laid upon their natural bed—*i.e.*, horizontal with their stratification. Any other position of the stone in the wall would cause its surface to shale off.

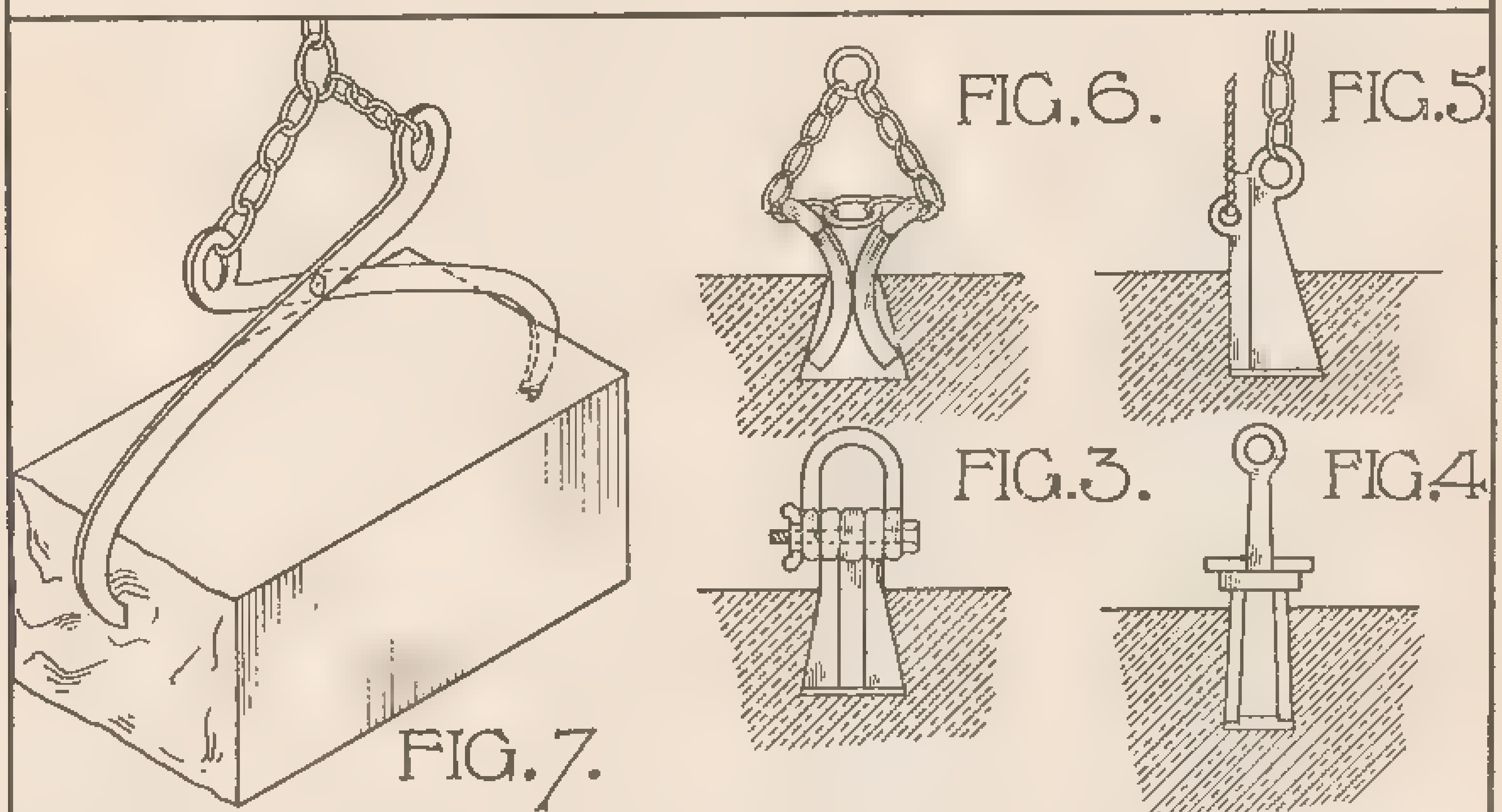
Stone-Cutting.—In the carrying out of stone work, it will at once be seen that a stone building must show different kinds of stonework in various parts of its construction.

The highest class of stonework—*i.e.*, all cube stone, technically called "ashlar"—is not always sustained throughout the whole structure, and even if it is, variation of surface working is necessary.

In ordinary walling, therefore, the greater area of the wall may be built with the stone as the quarry, in an ordinary way, is able



FACE WORKING OF CUBE-STONE



APPLIANCES FOR LIFTING STONES

to produce it. The characteristics of the stone being seized upon and its rapid dressing accomplished, it finds its place in the wall, in some kind of bond that best suits its capabilities. Thus, some stones are round or very irregular, others show sharp shaling fracture. Each class of material, therefore, has to be treated in such a way as to suit its own character.

All angles of a building, door and window openings, and the like, must be worked fair and framed with dressed work of some kind. If the infilling be not of ashlar, some kind of rubble is generally substituted.

Masonry in walling is generally built fair on the face to an average thickness, and backed up with more or less unworked stone, with "through stones" at intervals in each course.

In many cases a brick backing is built, and the stonework gauged in height to work in with brick courses. In either case the through stones are a necessary part of the bond, unless a hollow wall be made, when the two may be separated and bonded only with tie-irons.

Cube Stone.—Plate LI., figs. 1 and 2, shows the various face workings of cube stone.

This class of preparation is carried out in some suitable place near the building, the various stones being afterwards lifted and set in the work.

Rock or Pitch Facing consists of forming a fair edge all round the stone and roughly spalling off therefrom, leaving the surface in its natural state.

Picking is done with a mason's pick. This is a rapid method of bringing a soft stone to a fair face. There is picking and fine picking.

Drafting consists in forming a frame margin round the stone. This may be plain or tooled.

Plain Facing is bringing the stone to one even and smooth surface.

Vermiculating is generally confined to the finishing of quoins. It consists of irregular insinkings below the general surface of the stone.

Furrowing is fair sunk tooling in parallel lines.

Dabbing or Sparrow-Picking is lightly punching the surface after it has been plain faced.

Plain Sinking is forming a fair framed depression in the stone.

In addition to these surface finishings the joints may be chamfered or rebated, either all round or along the horizontal joints only.

Beds and Joints are prepared with more or less smooth finish according to the class of work. In ashlar they are either sawn, axed, or punched fair.

WALLING.—For various kinds of walling see Plate LII.

The character of the work in walling varies considerably, the simplest kind being classed as "rubble."

Rubble may be either uncoursed or coursed, random or squared.

Uncoursed Rubble consists of stones built, bonded, wedged, and mortared together without regard to horizontal coursing. This is done where stone is naturally of very irregular shape, the strength of the wall having to depend very largely upon mortar.

Coursed Rubble is where rubble is used, but at certain heights, or courses, the work is horizontally levelled up.

Two kinds of coursed rubble are shown in Plate LII., figs. 1 and 2, and there are others.

Fig. 1 shows a good practical type of wall much used in some parts of the Commonwealth, the base course and quoins being of brick, with infilling of coursed work equal in height to four courses of brickwork. The stones, being of differing shapes and sizes, are built in to break joint, with through stones about every 5 ft. centres in each course diagonally. This is squared rubble built in courses. Should very irregular stone be used the work would be described as "random rubble" built in courses.

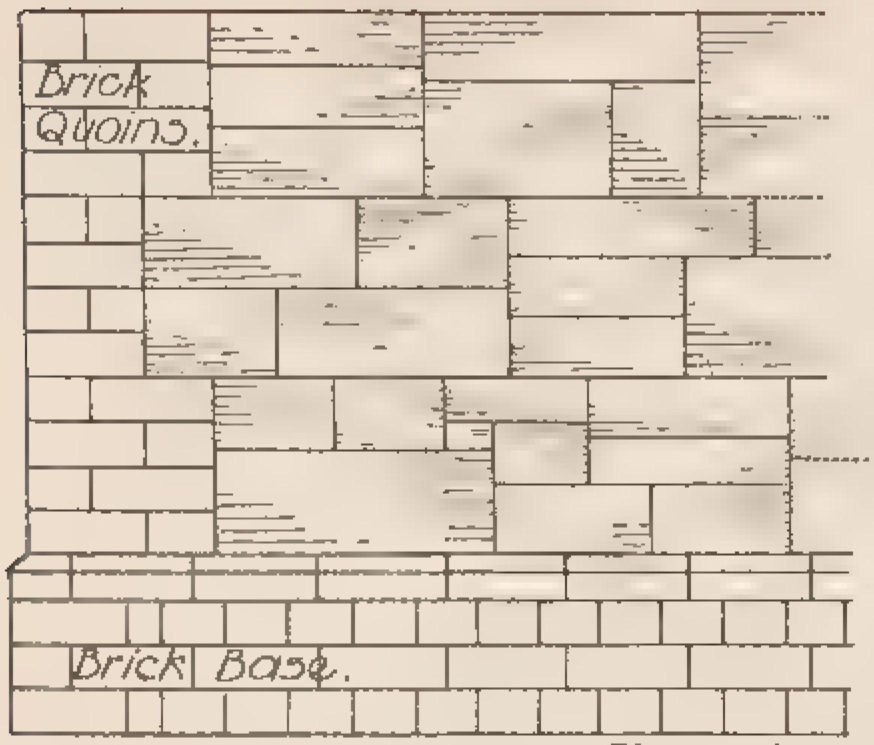


FIG. 1. Squared Rubble built in Courses.

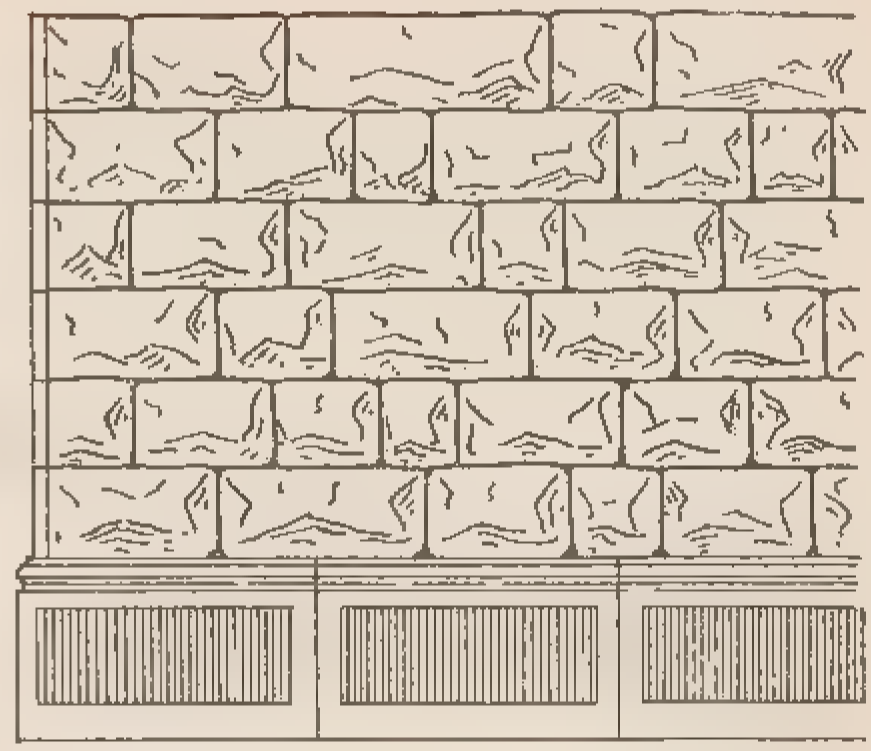


FIG. 2. Regular Coursed Rubble.

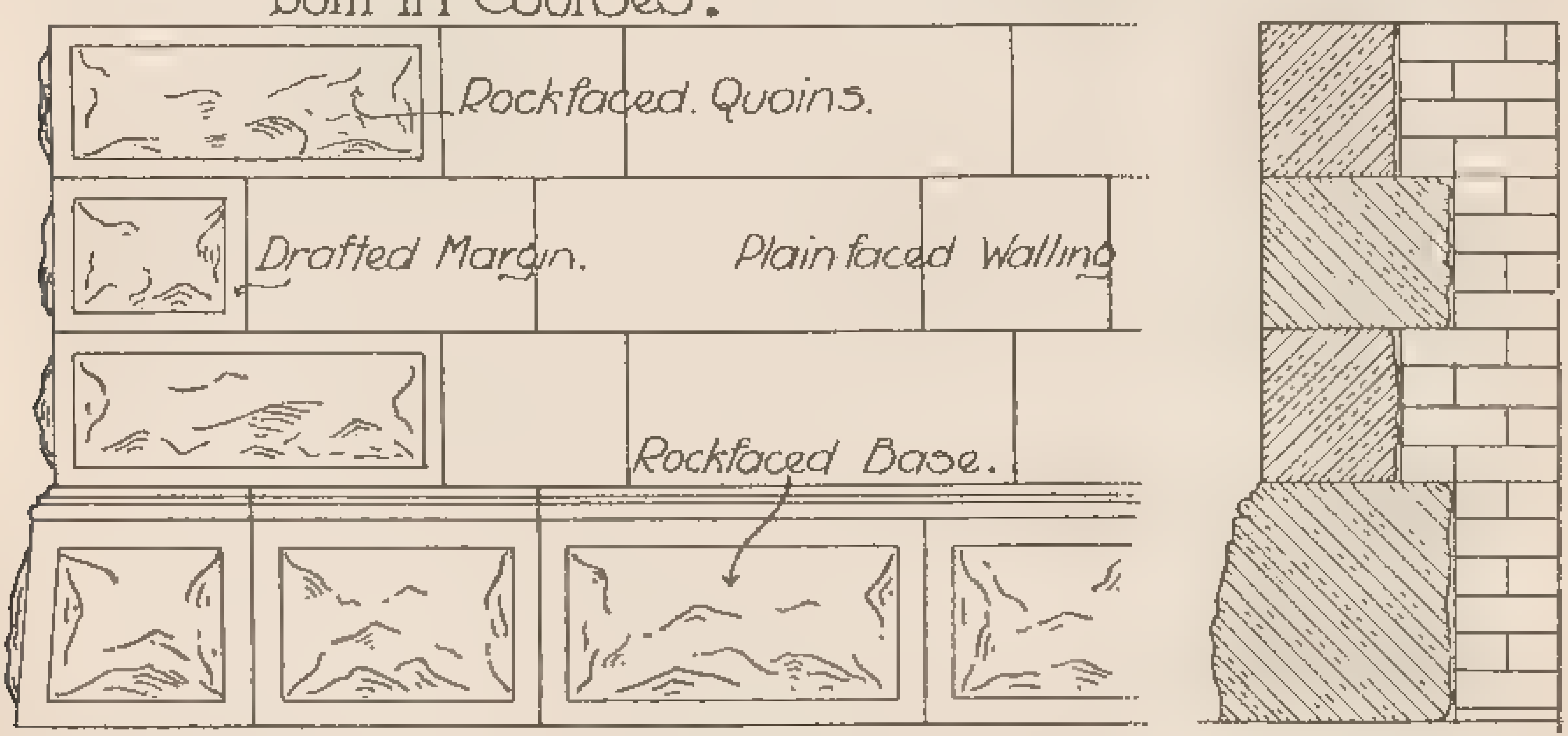


FIG. 3. Plain Ashlar Walling. Section

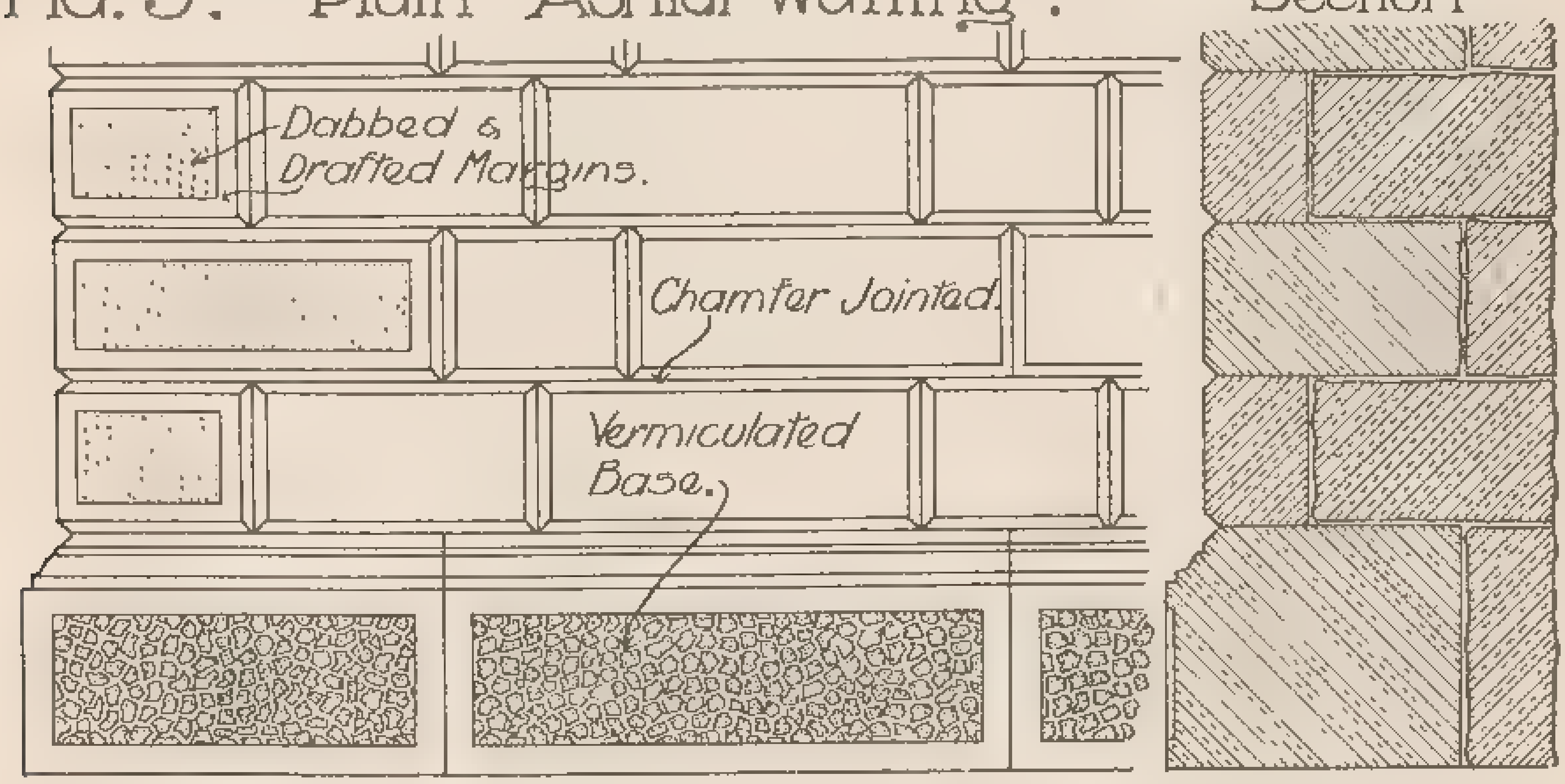


FIG. 4. Chamfer-Jointed Ashlar. Section.

STONE WALLING

Regular Coursed Rubble is shown in fig. 2.

This is where the stones in each course are all the full height of course. Where there is no brick backing, the courses are sometimes irregular in height.

In this figure a molded base is shown with rubbed margin draft and vertically tooled panels. The external angle of the wall is finished with a plain margin draft, the rubble being natural faced.

Ashlar is a common term, meaning the highest finished masonry. It is entirely distinct from rubble.

Ashlar may refer to walling or parts of walling worked in a great variety of ways, but it is always out of cube stone.

Plain Ashlar (fig. 3) shows a wall in plain rubbed ashlar, where the courses are regular, the stones showing alternate headers and stretchers in each course.

This wall is in face work, the wall being backed up with brick (see section). Through stones are necessary, about 5 ft. apart in each course.

The quoins or angle stones are rock-faced, and worked with margin drafts, the base course being the same, but molded on top.

Chamfer-jointed Ashlar is shown in fig. 4.

The general walling here has a rubbed face, the joints being worked with chamfers that intersect and mitre and form all round V joints. A somewhat similar class of work is sometimes worked with rebated or channelled joints, either all round the stone or in horizontals only (see Plate LIII., fig. 1).

In Plate LII., fig. 4, the quoins, after being rubbed, are dabbed or sparrow-picked in panels. The base course is molded on top, and has vermiculated panelling.

The section shows the wall as stone right through, and the method of cross-bonding.

Where possible, the base stones are best right through the full thickness of the wall.

Setting Out Masonry.—All mason's work requires to be

specially planned and set out by skilled artisans, for, unlike brick-work, the material offers great variations of treatment, both in size of stone and arrangement of setting.

In this the student would do well to systematically study the old examples, which reveal methods of building that have withstood the wear of the ages.

Classic architecture specially shows the treatment of "regularity." for which see Greek, Roman, and old Italian work.

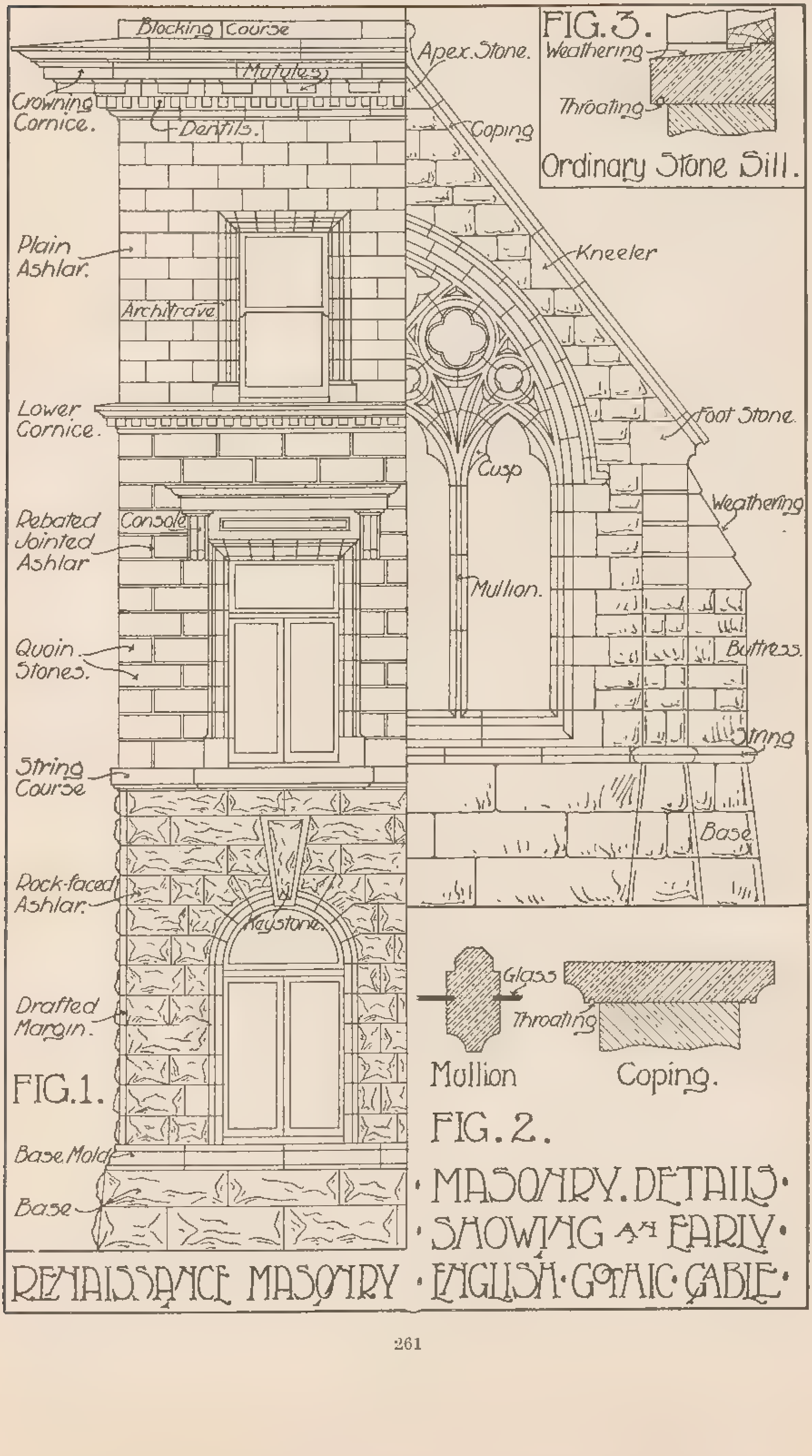
The Gothic of the mediæval period in Europe specially demonstrates the art of masonry with "irregular" material. In this manner, especially, full opportunity is taken to use stone in all varieties of height and size. The deep recessing of heavy walling. the beauty of molded and enriched doorways, the through-piercing of traceried windows, the over-arching of flying buttress, the stately uprising of pier arcades, and the crowning glory of vaulted roofs all revealing the work of a great masonic age.

Further, stone building, compared with brick building, is slow. It may therefore the more deliberately be set out and arranged, and the opportunity, that variation of material gives, be fully availed of for original treatment.

Surface Appearance.—Plate LIII., figs. 1 and 2, shows the setting out of two simple types, one Renaissance the other Gothic. This plate also gives opportunity for illustrating a large number of technical terms.

In the Renaissance masonry, fig. 1, the corner of a three-story building in the Italian manner is shown. First there is a rock-faced and battered base, finishing with a molded base course, which acts as a sill to the ground floor windows. These windows are recessed and finished around with a draft margin and cavetto mold. The semicircular arch is radiated into the general walling of rock-faced ashlar, and finished with a bold keystone.

Next comes a molded string or sill course for the first floor windows. Here the work is of rebated jointed ashlar, smooth rubbed, the window being framed with a molded architrave, over-


Blocking Course
Mutules
Crowning Cornice.
Dentils.
Plain Ashlar.
Architrave
Lower Cornice.
Rebated Jointed Ashlar
Console
Quoin Stones.
String Course
Rock-faced Ashlar.
Keystone
Drafted Margin.
FIG. 1.
Base Mold
Base
Apex Stone.
Coping
Kneeler
Cusp
Foot Stone.
Weathering
Mullion.
Buttress.
String
Base
FIG. 3.
Weathering
Throating
Ordinary Stone Sill.
Glass
Throating
Mullion
Coping.
FIG. 2.
RENAISSANCE MASONRY
· MASONRY. DETAILS ·
· SHOWING AN EARLY ·
· ENGLISH · GOTHIC · GABLE ·

shaded at top with a molded canopy, supported on two molded and carved consoles, with sunk panel between. On top of this second story comes a molded lower cornice, with projecting dentals; this is called a denticular cornice.

The third (top) story is built of plain rubbed, regular ashlar, the window being framed with molded architrave. This architrave, being built of small stones, is radiated at the head and secret joggled at the back.

The wall is finished with a bold crowning cornice, in three course work, consisting of molds, dentals, and projecting mutules, a blocking course crowning all.

The setting out of an early English Gothic gable is shown in fig. 2. This gives an opportunity for illustrating the method of jointing in this class of work, together with certain technical terms peculiar to the Gothic.

Here we see the use of irregular stone, which gives that variation so characteristic of Gothic art. All the special parts are worked to smooth rubbed face, such as windows, copings, buttress tops, &c., the general walling being of squared rubble. The base course is in large stones set to batter and finished with a molded string course. There are two angle buttresses with water table weathered tops set at a steep angle. The window is of finely worked stone, filled with tracery, the jointing of which is clearly shown around the tracery. There is first of all the molded and steeply weathered sill, the quoins, and the arch, the latter being finished with a projecting label mold.

For the purpose of receiving the leaded stained glass, with which this class of window is filled, a raglet, or channel, is cut in the stone all round. (See Mullion detail.) This raglet follows all round the tracery and receives the glass, which is bent or built into it.

The finish of the wall here shown is termed a "gable"—a stone gable. This is cover finished, with a wide stone coping in long lengths so worked as to throw off water, projecting mold and throating underneath. (See detail.)

To hold this coping in position there is the "footstone," and, higher up, the "kneeler," the whole being finished with a shaped "apex stone."

Rods.—Long wooden rods, upon which the vertical joints are marked, are used for setting out masonry, a similar method being adopted in important work for the horizontal jointing. Projections, recessings, piers, and all variations from plain building are set out on templets—*i.e.*, patterns of the actual size of the finished work. These may be of thin boarding, nailed together and cut to shape, or of sheet metal.

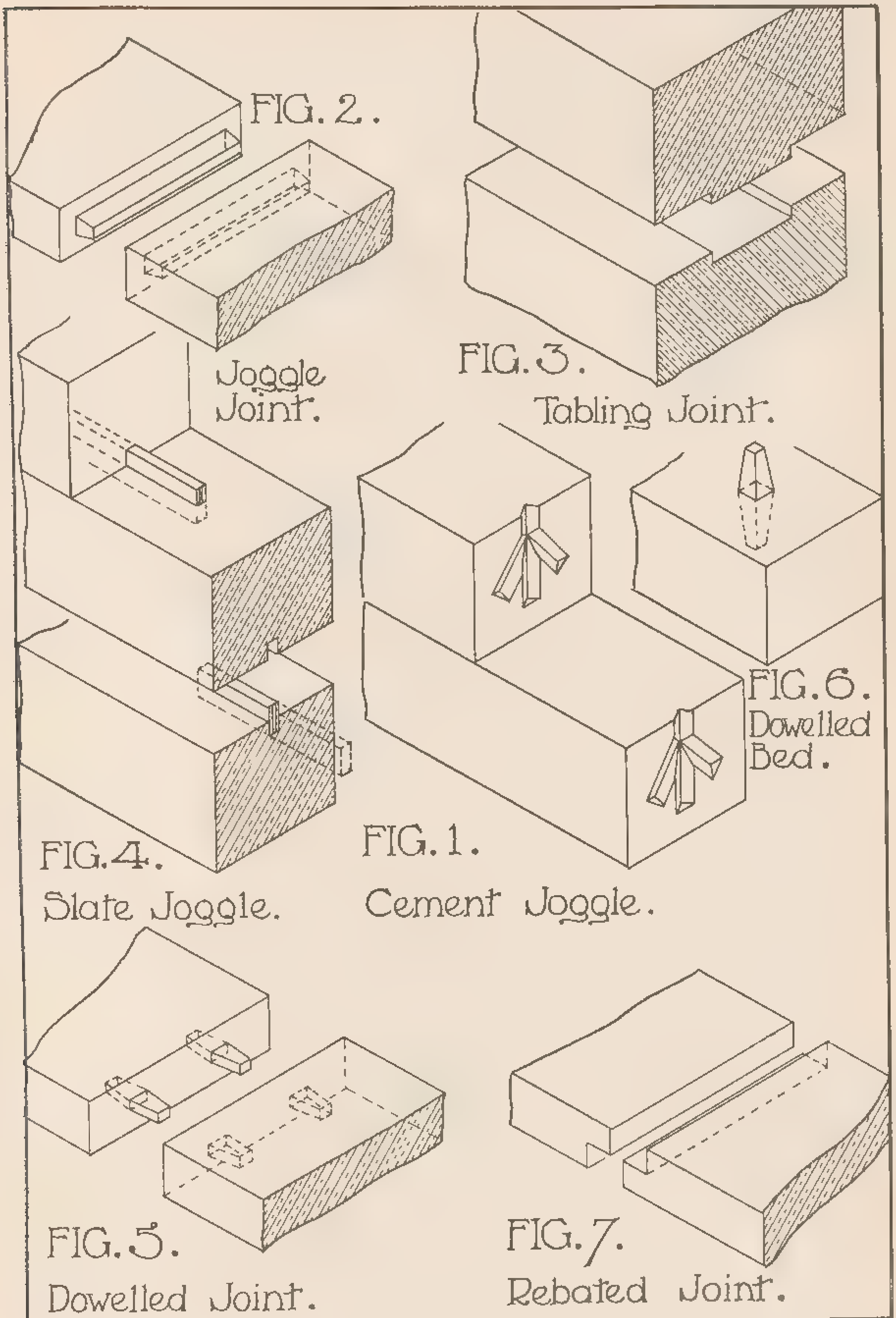
Templets.—For all molded work, and especially in Gothic masonry, a large, smooth, floor-like table is provided, upon which the full-sized details are drawn. These are then reproduced on zinc, the contours being sharply cut out for the use of the working masons.

From the templet the actual stones are marked, and worked to correspond. In the case, for example, of an ordinary molded cornice, the stone is worked fair at the ends, the templet laid on, and the outline taken. Thus, having molded contours marked at either end, the mason proceeds to work the stone fair in between from end to end. In this way the molding is produced.

Carving.—For carving, the necessary stone in the rough is generally built in, the carving being executed in position, towards the end of the work.

Carving should always be first modelled in clay and criticised before being carved. This gives practical opportunity of judging of its effect before the unalterable work in the final material is begun.

Artificial Jointing.—In addition to the general method of mortar jointing, there are various devices for specially securing large stones together. (See Plates LIV. and LV.) These are so planned as to resist the various thrusts and strains to which the work may be subjected.



VARIOUS JOINTS IN MASONRY

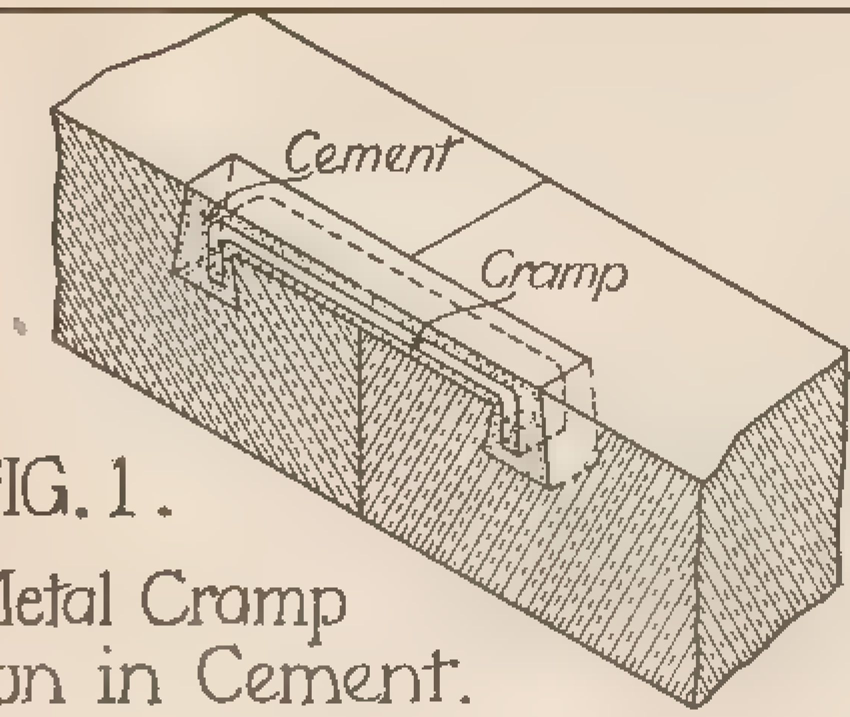


FIG. 1.
Metal Cramp run in Cement.

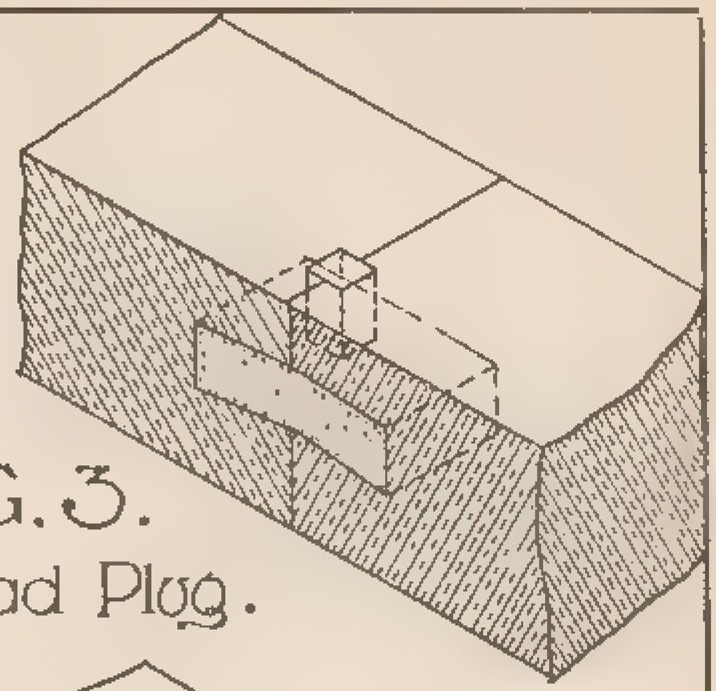


FIG. 3.
Lead Plug.

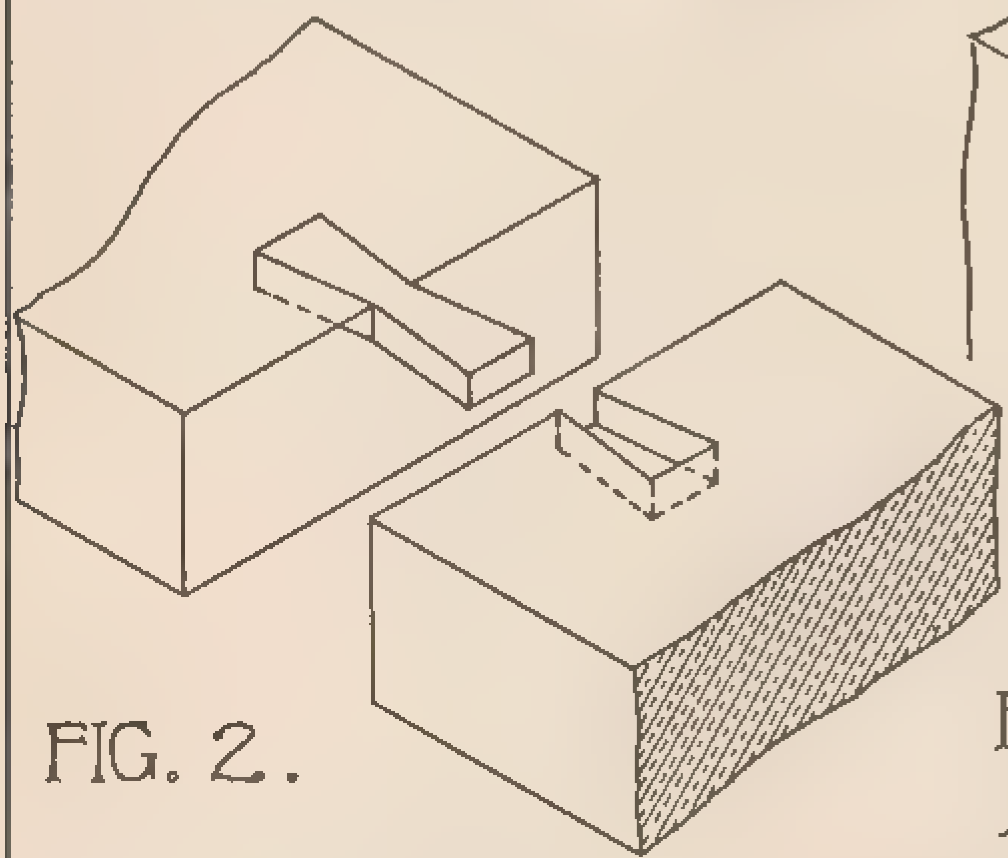


FIG. 2.

Slate Cramp.

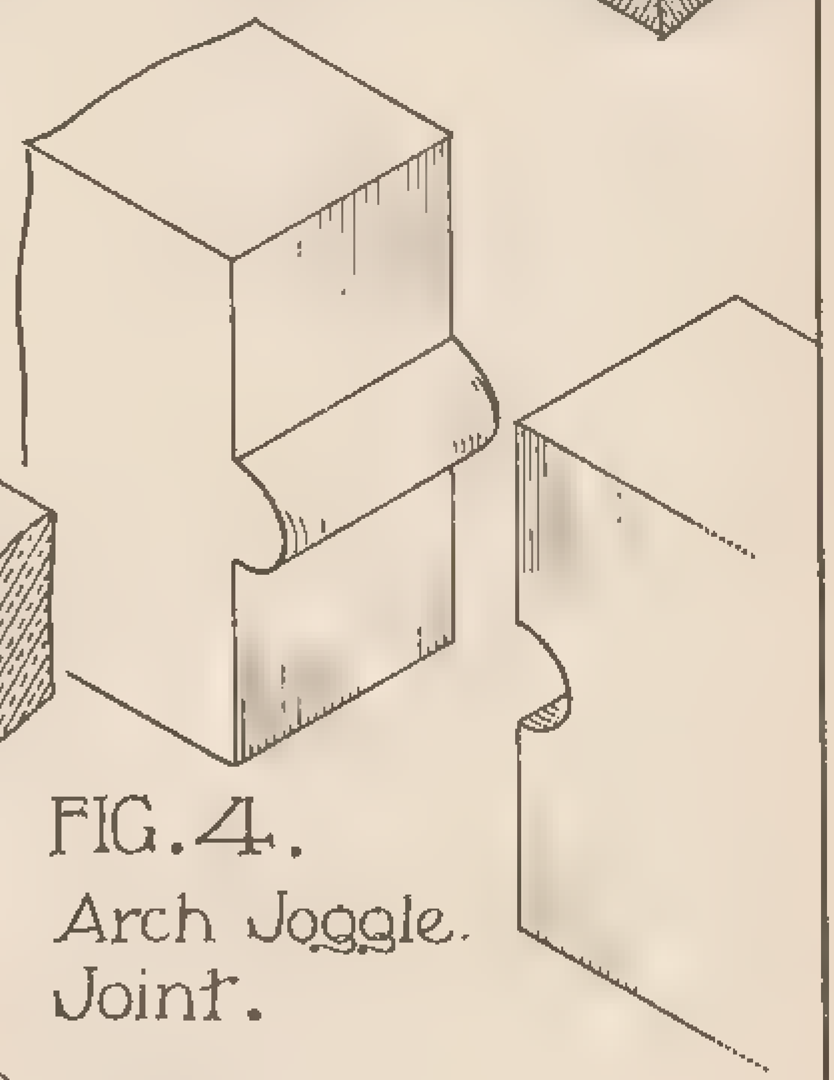


FIG. 4.
Arch Joggle Joint.

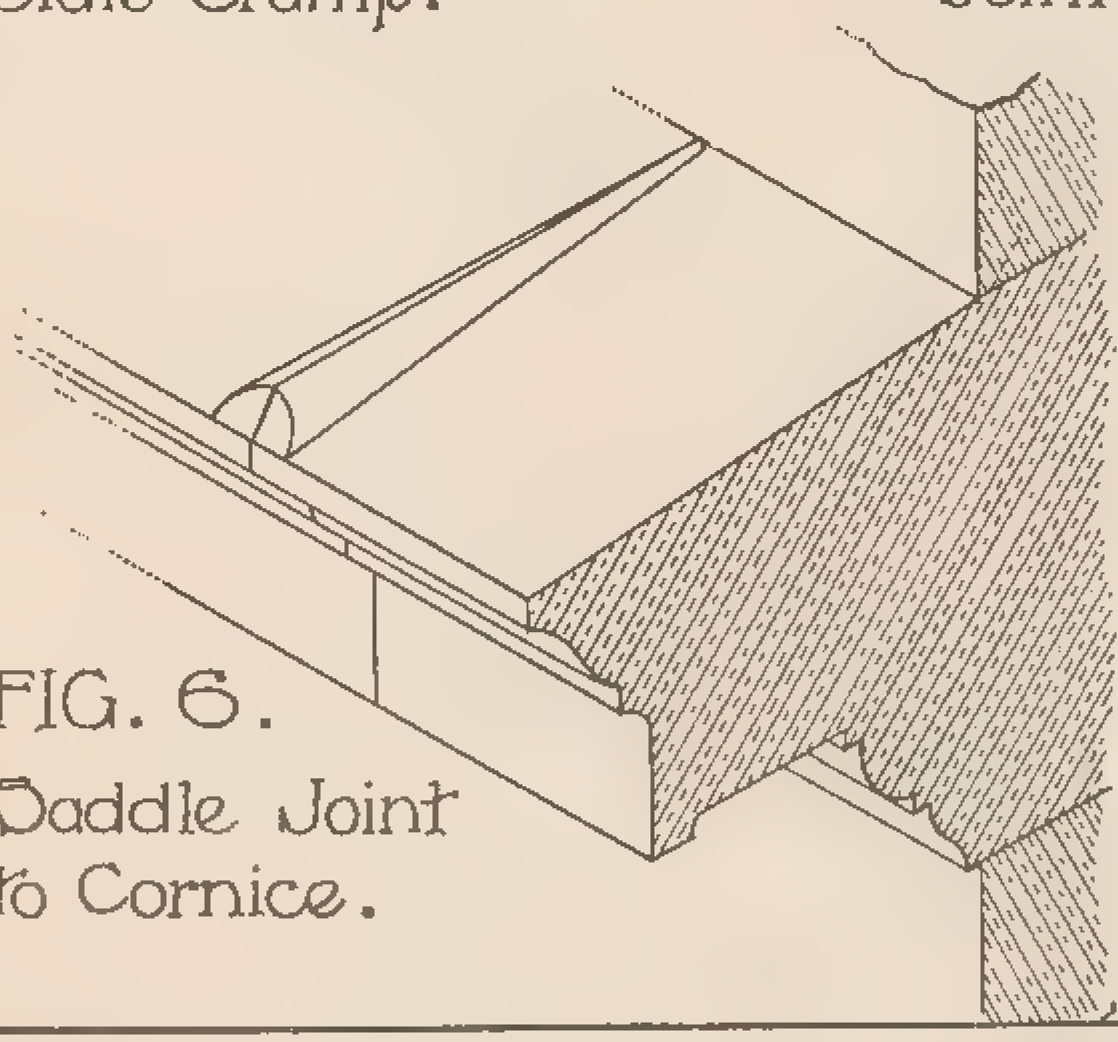


FIG. 6.
Saddle Joint to Cornice.

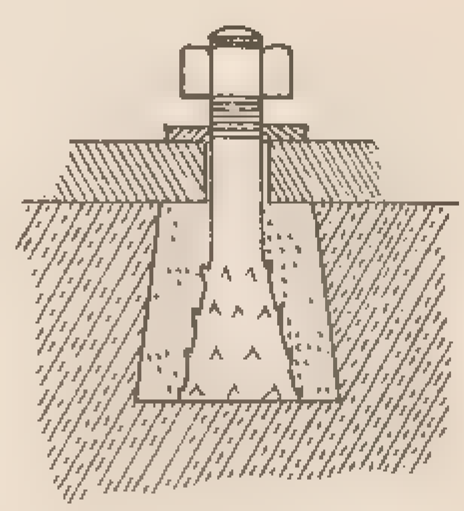


FIG. 5.
Rag Bolt.

† VARIOUS JOINTS AND CONNECTIONS IN MASONRY †

Such joints are made in some cases in the stone itself, and in others the introduction of some binding substance is resorted to, such as metal or slate.

In metal jointing, or in using metal in any position in stone-work, the danger of iron oxidization must be strongly urged. Raw iron in contact with stone and damp will lead to oxidization, oxidization to expansion, and expansion to the bursting of the stone. Raw iron should therefore be kept away from stone as much as possible, and when used, as in railings, &c., some interposition of slightly elastic material, such as mastic or lead, is necesary.

Cement Joggle.—The simplest form of special jointing in masonry is the cement joggle. (Plate LIV., fig. 1.) This is made by hollowing out small channels at the end of abutting stones, the channels corresponding the one to the other. When set these channels come opposite each other, and are filled with liquid cement, thus forming a corrective against any lateral (sideways) strain.

Joggling and Tabling.—Other joints doing somewhat similar work are—fig. 2, "joggle joint;" fig. 3, "tabling joint;" and fig. 4, "slate joggle."

Dowels are common devices in stone. They are best of copper (as not being subject to serious oxidization), galvanized iron, or slate.

Fig. 5 shows a "double-dowelled joint."

Fig. 6 is a form of upstanding dowel, very largely used in thresholds to receive solid wood frames. An ordinary dowel is made of cut lengths of galvanized iron tubing.

Rebated Joint.—Fig. 7 shows a "rebated joint"; this is often used in wide stair landings.

Cramps of various shapes are constantly used in good work, the common form being shown in Plate LV., fig. 1; this is of flat wrought iron, forged and turned down at ends and galvanized. For this, a cavity is cut half in each stone, and the cramp is then

laid in position and cemented or leaded in. This is a device for withstanding tensile strain.

A slate cramp to do similar work is shown in fig. 2. This is dovetail-shaped and close fitting, the slate being sawn.

Fig. 3 shows a cramp created by molten lead being poured into a prepared cavity, half in each stone, with pour-hole at top.

Arch Joggle.—A common form of arch joggle is shown in fig. 4. This enables an ordinary wall opening to be spanned by a flat, arch-like form, in small stones, the joggle holding the one stone by the other. This is a device also much used in terra-cotta. In this joggle the sides of each stone are best cut to radiating lines.

Rag Bolt.—Iron rag bolts are specially used to connect iron to stone, such as in the case of an iron stanchion being seated upon a stone base. The end of the bolt is opened out and left rough, so that the cementing material may get a good hold, the threaded end of the bolt being outstanding to pass through and be bolted on to the general ironwork (see fig. 5).

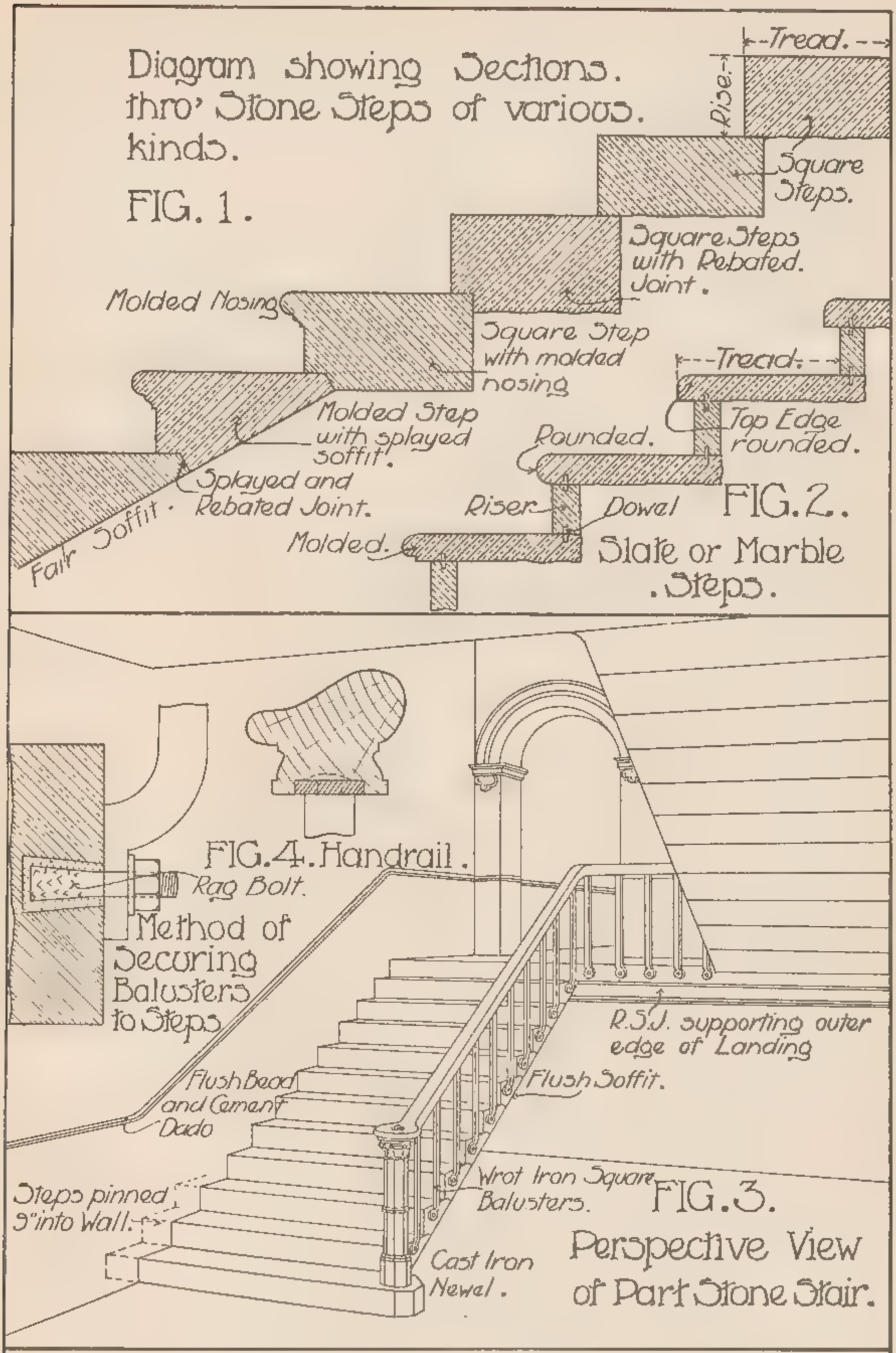
Cornice Saddle Joint.—Cornice tops require to be very specially protected against the soaking action of the weather. They, therefore, are worked and "weathered"—*i.e.*, sloped towards the ouside edge. To prevent rain water from soaking through the joints, saddle jointing is worked (fig. 6). This consists in leaving the stone rounded and at full height along each cross joint, thus throwing the water off.

STONE STAIRS.—Though necessarily differing in constructive detail, the general lines of setting out wood, stone, and iron staircases have much in common.

Stone stairs are mostly used in public or semi-public buildings where excess of traffic and fire resistance has to be combined.

Plate LVI., figs. 1 and 2, show various forms of steps.

The "tread" and "rise" should be carefully worked out to give easy going, and landings should be arranged at reasonable intervals so as not to make flights too long.



STONE STAIR DETAILS

The simplest form of step is the square step left rough on under sides resting $1\frac{1}{2}$ in. on the step next below. This resting may be alternated to a rebated joint, or the step may be worked with a rounded or molded nosing. Where the soffit shows fair from below, steps are best worked on the rake and with splayed and rebated joints, as shown in fig. 1.

Marble and slate being generally worked as slab material, the steps in these mediums may have the treads worked separately, and the risers set and dowelled on.

The steps, as also landing stones, of stone stairs require the ends to be housed or pinned into the walls, the outer portions being supported by underbuilding or girders.

A common form of open stone stair is what is called a "flying stair"—*i.e.*, one where the landings are rigid and the steps rebated jointed and pinned at ends into walls; the outer ends may then hang over or fly without further support. (See stair drawn in perspective, Plate LVI., fig. 3.)

Balusters and Handrails.—The balusters of stone stairs are best of metal, such as wrought or cast iron or bronze.

Newels requiring to be massive may be of ornamental cast work. In the stair shown on fig. 3 the balusters are of square bar wrought iron, curved out at the ends to stand over beyond treads to give as much width in stair as possible. These bars are forged, flattened, holed, and secured to the end of each step with rag bolts and nuts. The baluster tops are rivetted to a continuous flat upon which the molded wood handrail sits.

Many variations of this balustrading may be adopted, the more common method being to have ornamental cast-iron balusters sunk directly into the top of steps. Copper bronze handrailing is also specially suited to this class of stair.

Fig. 4 shows balusters and handrail in detail.

Hoisting and Setting Stone.—The modern tendency with stonework is to have stone dressed at or near the quarry. By this

means the cartage of waste is avoided, and machinery may be the more readily utilized where there is a continuous demand, as is the case with constantly worked quarries.

The raising of stone into position offers more difficulties than the upcarrying of bricks by means of the hod.

Stone, being heavy and often of great size, requires hoisting tackle. This is now commonly supplied in jobs of normal size by a universal crane. In extensive jobs travelling cranes are used.

Lewis Bolts.—For the same reason, the question of weight, the larger stones require to be upheld during the process of setting. This is generally done by some form of the Lewis bolt (Plate LI.) On this plate four different forms are shown. A wedge-shaped hole is sunk in the top of the stone to be raised, the bolt inserted, and the stone lifted and conveyed into position.

Lewis's or Lewis bolts all have the tendency to tighten and grip the more they are pulled.

Fig. 3 shows the old form of Lewis bolt, where three pieces of shaped iron are held together by a cross pin. Upon taking out the cross pin, the centre piece may be removed, thus enabling the whole to be released.

Fig. 4 is another form. By the down driving of the centre portion the two side wedges may be updrawn from the collar.

Fig. 5 is the form of bolt for use under water, the up-pulling of the left-hand wedge releasing the bolt.

Fig. 6 shows a simple form of shaped clutch.

Pincer or Clutch.—Fig. 7 shows the ordinary wrought-iron pincers or clutch, working on a centre pin (like scissors). These are shaped to grip the stone at the sides, and, being shackled up at the top through the ring ends, create a firm grip hold. It will, however, at once be seen that pincers cannot carry a stone exactly into position like a Lewis. The pincer can carry a stone to the wall; a bar must then be used to prise it into position.

Actual Building.—*Brick Backing.*—One of the first questions

to decide in stone building is whether the walls are to have a brick backing or not. In large city buildings the brick back is generally put in as offering economy of stone and certain other advantages.

Fixings.—If all stone be used, the building in of fixings for woodwork of every kind such as skirtings, door and window linings, &c., must be thought out, as plugs may not be so readily secured in stone as in brick walls. These fixings may be made between built-in twin bricks or through built-in coke breeze bricks or similar devices.

Foundations.—The general principles laid down in Chapter X. for foundations of brick walls apply equally to stone walling.

Foundations are best started with a course of very large flat stones well flush bedded and with as few joints as possible, set in cement.

Mortar.—For mortars see chapter on brickwork.

It is highly important that mortar for stonework should be good, and the joints well filled, for here, more than in brickwork, the joints are often unequal in thickness. Especially important is this in rubble work, where much depends upon the adhesive power of the mortar used.

For all high-class stonework cement mortar should be used. In face ashlar work the outer joints are generally set with tow, which stops the liquid grouting from defacing the face work; when set the tow is withdrawn and the joints pointed up in cement, tuckpointed, or stopped with putty or mastic.

Rubble Wall Building.—In building rubble walling much will depend upon the skill of the actual workman handling the stone, and care should be taken to well break joint, tightly wedge, and to avoid any centre infilling with spalls. Coursing up at intervals (though not always done) is highly to be recommended in all work.

Cube Stone Setting. –The highest finished stone may be set with extra fine joints, which should be allowed for. The great

importance of true bedding, especially if the stones are of great size, should here be pointed out, as, should the superincumbent weight be directed on one point rather than upon the whole bed of the stone, serious fracture is liable to take place. For this reason, in finely jointed work the beds should be true, and especially the lower beds, which, on account of not being readily seen upon direct inspection, are liable to be neglected.

Casing.—All important parts of stonework require to be temporarily cased with wood to protect them from injury as the work proceeds. The same must be withdrawn from the top downwards as final cleaning down is done.

STONEWORK FOR ORDINARY BRICK BUILDING.—The mason's work for an ordinary brick building comes more often within the scope of the designer than an all stone building, especially in those parts of the Commonwealth where brick is readily available. It may, therefore, be desirable to refer briefly to the stonework generally used, such as sills, thresholds, lintels, cores, templets, &c.

Sills.—Window sills are best of hard, impervious stone. For ordinary-sized windows they should be at least two courses of brickwork deep. If projection is required, they may be worked as shown in Plate LIII., fig. 3—*i.e.*, rebated at top to offer a check to water liable to soak under wood sill, weathered on top, projecting 2 in., and throated out underneath to enable the water to drip off instead of running down the face of the wall. Such sills should be 9 in. longer than openings, worked fair, and bedded at ends, and left free underneath till the end of the job, when the brickwork has settled. The joint may then be pointed up.

Thresholds to outside doors should also be of the hardest stone available, full thickness of walls, at least two courses of brickwork deep, 9 in. longer than openings, and slightly weathered outwards. These usually require to be metal dowelled at ends to take upstanding solid wood frames.

Lintels.—If openings are spanned by stone lintels, the thickness of the stone should be from the face right back to the wood frame (if any), the bearing at each end being 7 in. The depth of stone will depend upon the opening to be spanned and the weight-bearing capacity of the stone. Stone lintels are best relieved by arches built over them.

Templets are pieces of stone built into walls to take the ends of rolled steel joists, girders, roof principals, or similar special weights. They, too, should be of hard stone, worked on top to a fine face and of sufficient thickness and size to spread the weight upon the general walling. Where girders rest upon stone templets, they are best set on a sheet of heavy lead; this secures equal and easy bearing.

Cores.—For projecting outside stucco cornices, stone cores are often required, especially where projections exceed the limit possible with brick projection.

Such cores may be carried out in slate (if available). For stucco finishings bluestone offers a better key than slate, while for shallow depth overhangs roofing slates set in cement offer a handy medium.

Technical Terms.—The student is referred to the various masonry plates for technical terms used in this craft.

The terms are very numerous, many of them having special references to Classic, and others (the more numerous) to Gothic art.

CHAPTER XII.

CONCRETE CONSTRUCTION.

Concrete Generally.—The use of concrete as a structural building material has its origin in the very earliest of classic ages, some of the best work being still extant in old Roman edifices.

In modern practice in districts where suitable conglomerate is more readily obtainable than either stone or brick, concrete structures are sometimes erected, the concrete taking the place of the more commonly used material.

Concrete is used in different ways: As a simple monolithic mass, by being made into blocks which are afterwards built into the work; or as reinforced concrete—*i.e.*, steel framework encased in concrete. Apart from this type of practice, concrete is useful in ordinary building work, for fire-proofing in floors, for the overcarrying of lintels and projecting overhead masses such as bays, oriels, &c., and in many other ways.

The remarks which appear in Chapter X., with regard to concrete in foundations, apply equally to concrete as referred to in this chapter. The principle of mixing and application is the same, save that, with the variation of work and position, the size of the basic material differs.

Monolithic Concrete.—Monolithic concrete consists of the use of concrete for walls, &c., in place of brick or stone. This is usually done by erecting suitable close-boarded boxings or incasements in position, into which the concrete material, in a plastic state, is cast, rammed, and allowed to harden, after which the woodwork is removed. This mode of construction calls for some ingenuity in

arranging the woodwork in the most effective and economical manner, especially with regard to its repeated use during the progress of the work. No one system can here be laid down as a guide, though certain patent as well as a number of general systems are known to be in use.

For this class of work the concrete will greatly depend upon the local material available, and may consist of any clean, hard, broken stone, scoria, gravel, burnt clay, &c., mixed with sharp sand, and bound with Portland cement or good lime.

Concrete in Blocks.—Walls are sometimes built of concrete blocks in much the same way as with blocks of stone, save that the blocks are made of regular sizes. Such blocks are usually cast solid in molds, allowed to harden, and afterwards built into the walling with mortar. Another system is where hollow interlocking blocks are made, by machinery, for the purpose, and built in in the same manner as the solid blocks. These have the advantage of leaving the internal parts of the walls hollow—a proceeding which tends, in some degree, to equalize the internal temperature of the building.

Coke Concrete in Lintels, &c.—A practical use for concrete in ordinary brick building is made by building the lintels in coke concrete. This material, if carefully made, is light in weight, and will carry over considerable distances. It further has the advantage of offering secure fixing for woodwork—an advantage not available so readily in concrete having stone as a basis of its composition.

In addition to bridging over openings, coke concrete is useful in encasing steel joists, in forming cores for columns, in carrying outjutting, projecting structural features, and in other ways. Coke concrete for such purposes is best made with coke broken to a 1-in. gauge, washed free from dust, and mixed with good Portland cement in the proportion of one part of cement to three parts of coke. The concrete should be laid in position, in proper wood

casing or cradling, and arranged to give full bearings upon the walls so as to carry the weight.

Fixing Bricks.—Coke concrete fixing bricks are also of great advantage for fixing joinery. These should be the full width of the walls, of the size of ordinary bricks used, made separately, set about 18 inches apart centres, and built in with the ordinary work. These bricks may be made of clean, washed coke, broken to a $\frac{3}{8}$-in. gauge, and mixed with Portland cement and sand in the proportion of two parts of coke to one part of sand and one part of Portland cement.

Floor Concrete.—Floors next the ground, where impervious surfaces are required, are often laid in concrete and finished in cement. Concrete is also used as a foundation for tiles, mineral asphalts, and other impervious floor coverings.

In upper floors where fire-proofing is required, the most common method employed, apart from reinforcing, is carried out by means of rolled steel joists, set at certain fixed distances apart, bridged over with close-set sheets of galvanized corrugated iron, curved upwards from below and resting upon the lower flange of the joists, and with the joists of the iron close-rivetted. Upon the top of this decking the concrete is laid, being levelled off fair at top, usually to a thickness of about 4 in. at the crown of the iron, the distance apart of the joists, the camber of the iron, and the thickness of the concrete being regulated by the weight-bearing capacity of the floor required.

Concrete for floors varies with circumstances, but a good working compound is made with one part of Portland cement, two and a half parts of sand, and five and a half parts of bluestone or granite screenings.

Reinforced Concrete.—Reinforced concrete must be considered as among one of the most important factors in modern building.

This method of construction, which is also known as ferro-concrete, armoured concrete, and concrete steel, consists of the application of a principle first applied by Monier in 1867, and which has since been highly developed and extensively practised, especially in engineering and building works of a permanent character.

By Monier's discoveries it was found that concrete could be strengthened to an almost unlimited degree by being armoured or reinforced with steel, which fact has been, by test and actual building, applied under a great number of patent and standard systems, too numerous to mention in detail here.

In its simplest form, wire-netting embedded in concrete supplies an object lesson of its application. In this way such articles as sinks and tanks may be efficiently made of material not more than ½ in. to ¾ in. thick, and baths from 1½ in. to 2½ in. thick. Pipes, too, of considerable diameter, are made from ½ in. thick and upwards, whilst circular tanks up to 15 ft. diameter only require to be 3 in. thick.

This material is applied to the making of almost any article required in or about a building, including walls, floors, roofs, stairs, landings, pavings, pipes, and even posts.

In engineering work it has been successfully applied to all kinds of work, from reservoirs to railway sleepers and telegraph poles.

Reinforced concrete is a monolithic system of construction, not an assemblage of parts, but a united whole, of which the steel is designed to take the stresses which the concrete itself would be unable to take, and to so bed in and cover the steel as to render it free from the action of the atmosphere, and, as far as possible, impervious to the destructive action of heat in the case of fire.

This combination of steel and concrete may be applied in many different ways, varying with the class of building, the nature of the foundation, and the character of the conglomerates used.

In its application it is at once seen how space is saved, both upon the ground and within the floors and walls of a building, by the reduction allowed when the various parts are of reinforced concrete,

the usual floor in this medium being only about 3 in. or 4 in. thick, with all other parts proportionately reduced from the sizes usually allowed in the older system of building with brick and stone walls and wood or steel and wood floors.

Such a building is practically indestructible, and offers valuable impervious surfaces both inside and outside for any finish that may be put upon it.

The large amount of temporary casing and centring required to hold the concrete in position as the work proceeds is an important item in the cost, and leads somewhat towards the repetition of parts in such a way that the same timberings may be used and repeatedly re-used in the same work.

Objection has been taken by some authorities to the non-artistic character of reinforced concrete as a building material, chiefly on account of its monolithic character, which is so much at variance with the traditional idea of structural stone and brick walling, combined with lack of texture in that material itself, which leads somewhat to deadness and coldness in wall surfaces. It is, however, to be hoped that these objections may, in a measure, be overcome by the advantages offered by the material for modelling and molding the ornamental parts of the structure, and for the application of ceramic and other color surface treatments to the walling.

It has also to be remembered that no one system or type of building can ever be of universal application, the application of a system being largely influenced by place, available material, and circumstance; and what is true of other systems is true of reinforced concrete. It has its place, and a very important place, in buildings of a permanent character.

Different Systems.—The systems used for reinforced concrete are now very numerous, and a great many books have been written upon the subject and tests made which the student seeking information should study, and it should be understood that in no system of construction is the importance of exhaustive calculation,

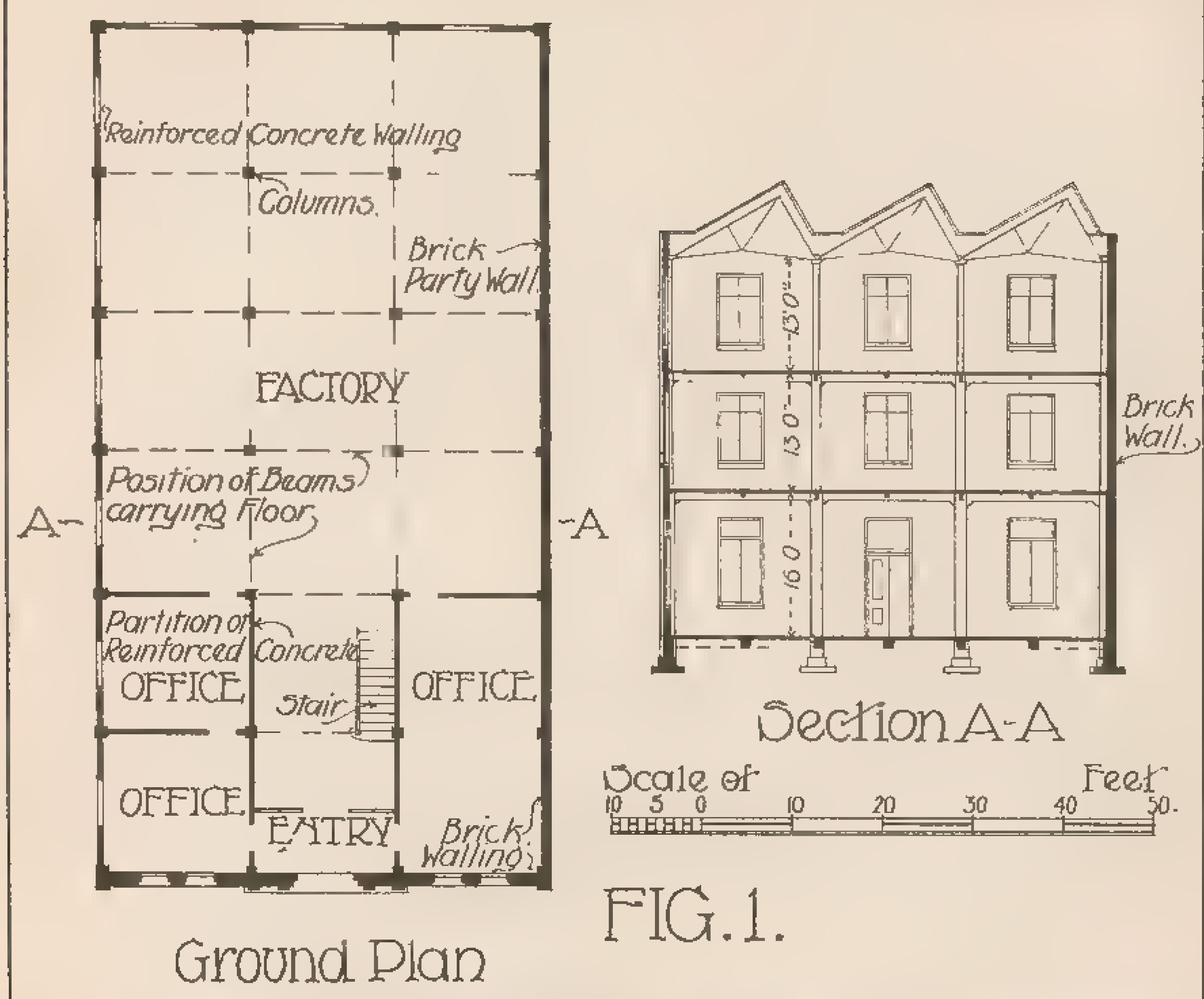


FIG. 1.

FIG. 2.

REINFORCED CONCRETE

proved test, and absolutely reliable material and competent workmanship so necessary as in this class of work, which depends, in such an overwhelming degree, upon each part being equally reliable.

The systems in use differ chiefly in the method adopted for reinforcing, which consists, in some cases, of the exclusive use of round rod steel and wire, laid in, connected, and bent to various shapes, as required. Other systems are carried out with wire-netting or expanded steel, and yet others have special made indented bars, trussed bars, stirrups, and other contrivances for overcoming the various difficulties met with in the work. There are also various patent bars and systems designed specially to meet the requirements of reinforcing.

Plate LVII. shows a simple factory building, illustrating the application of reinforced concrete.

The building here shown (fig. 1) is three stories in height, with brick party and front walling. The two other outer walls and the whole of the internal floors, supports, &c., are in concrete.

Fig. 2 is an internal enlarged perspective view, showing the general construction of the interior, from which it will be seen that the upper floors are supported upon a series of columns. These columns carry up, one above the other, from the bottom to the top of the building, and support upon each floor the main cross beams, which again carry intermediate longitudinal beams, which in their turn support the floor slabs, the whole being regulated and reinforced in accord with the weight-bearing capacity required for each floor.

Plate LVIII. illustrates in detail three systems of reinforcing applied to the support of ordinary floors.

Fig. 1 shows the application of the Kahn bar system, which consists of specially shaped steel bars, designed in various sizes, and applied to the columns, beams, and slabs. It is claimed for this system that the special form of stirrup upon the bar is scientifically designed to effectively take up the tensile stresses in the work.

Fig. 2 shows the Hennerbique system, where the chief work is done by means of rod steel, detachable stirrups of special pattern being used in the beams.

Fig. 3 shows a combination of structural steel with reinforcement. Here rolled steel joists are used as uprights and as beams. These are covered upon exposed surfaces with expanded steel, with which material the floors are also laid, the whole being infilled and cased with concrete in the usual way.

Partitions may be made by the inlaying of vertical steel rods in the centre of their thicknesses, extending the whole height, and kept in position with wire, being afterwards encased in concrete. Concrete for reinforcing must of necessity differ according to the thickness of the work required.

At all times only the very best tested Portland cement should be used, together with clean, sharp sand and broken stone, gravel, clinker, or similar hard aggregate.

Concrete, if properly made, tends to improve with age, and from reliable test it has been shown that concrete compounded of one part of cement, two and a half parts of sand, five parts of bluestone screenings, will show in two years a strength in compression of 6,500 lbs. per square inch, and is a good all-round working mixture for ordinary reinforced structures.

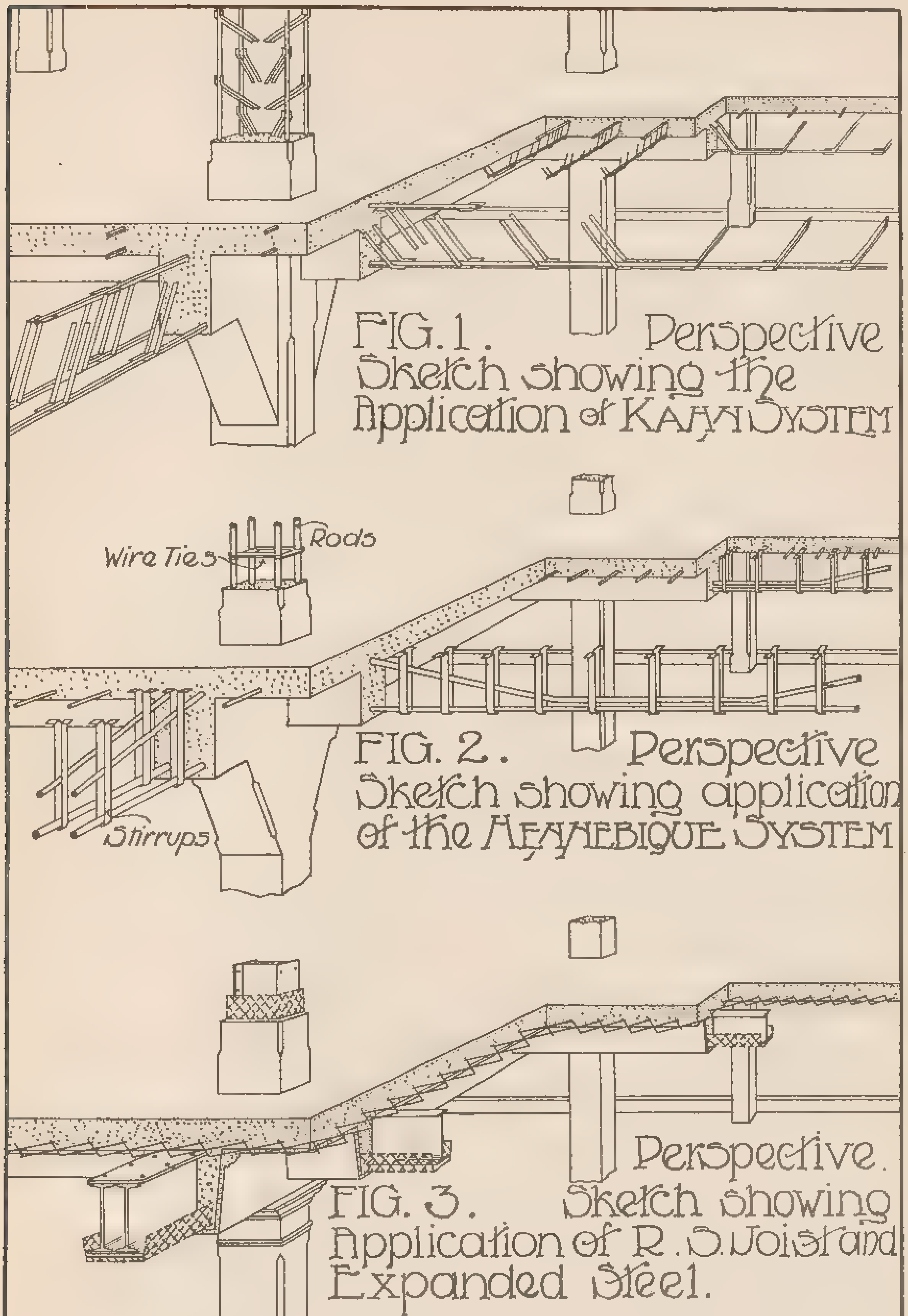


FIG. 1. Perspective Sketch showing the Application of KAHN SYSTEM

FIG. 2. Perspective Sketch showing application of the HENNEBIQUE SYSTEM

FIG. 3. Perspective. Sketch showing Application of R. S. Joist and Expanded Steel.

REINFORCED CONCRETE CONSTRUCTION.

CHAPTER XIII.

TERRA-COTTA, TILES, AND POTTERY.

Terra-Cotta.—The manufacture of architectural terra-cotta from clay earths has now been well established in Australia, the necessary natural products being found in abundance in various parts of the Commonwealth.

A good deal of interesting history centres round the manufacture of ceramics of all kinds, and the Old World potteries have been, and are, rich fields of interest for this constructive and decorative medium.

Terra-cotta is burnt clay used for constructive purposes. The general color is bright light red; but other colors, such as buff, pink, &c., are readily produced in certain of our districts.

Terra-cotta may be used as face work to outside walls, and for dressing and decorative features generally. It is highly lasting, and, if properly made, permanent in color. Of all materials, it works best in conjunction with brickwork, with which it supplies that pleasing relief that a larger material can give—a material, too, upon the same line of color, and capable of decoration.

Terra-cotta is generally backed up with brick or other permanent walling, and should be designed with full knowledge both of its capabilities and its limitations.

The first thing to remember is that terra-cotta is made from molded clay, the first process being to model the work in plastic, from which plaster of Paris molds are taken; the final material is then pressed into the molds, slowly air-dried, and afterwards fired in a kiln.

In all these processes there is a certain amount of risk, and skilled labor at every stage is required to regulate—first, the size of each piece; second, to secure, as far as may be, uniformity of thickness, so that shrinkage may be equal; and thirdly, skilful firing, so as to avoid fracture.

In setting terra-cotta, it may be chipped, rubbed, and fitted, and is best backed up solidly on the reverse side with cement mortar. As terra-cotta is hollowed and left rough at the back to regulate uniform thickness of the mass, this can be readily done, and good key is obtainable.

Pointing is best done with colored mortar.

For ordinary all-round work, each piece of terra-cotta is best kept within about 18 in. by 18 in.

The art of locking and infitting enters largely into the design of terra-cotta.

Band Course Design.—Plate LIX., fig. 1, shows a band course in terra-cotta, each piece being equal to three courses of brickwork, and $2\frac{1}{4}$ in. thickness over all, with about $1\frac{1}{2}$ in. of solid face thickness.

The decorative portions are confined to sets of three, plain slabs in sets of coupled threes being set between. This character of treatment keeps down the cost of the work, as only four molds are required, and the work repeats.

The top and bottom courses of the band are set with terra-cotta molds, equal in depth to one course of the brickwork. In this position ordinary molded bricks are often placed.

Terra-cotta lends itself specially to this kind of outside surface treatment, and decorative diapers, bands, and panels may be worked out in a similar way.

Anything that can be done in stone of small size can be done equally well in terra-cotta, the laws of jointing being similar (see Masonry). There is, however, this difference, that, whereas stone is solid and self-sufficient for support, terra-cotta needs filling, backing, and hanging.

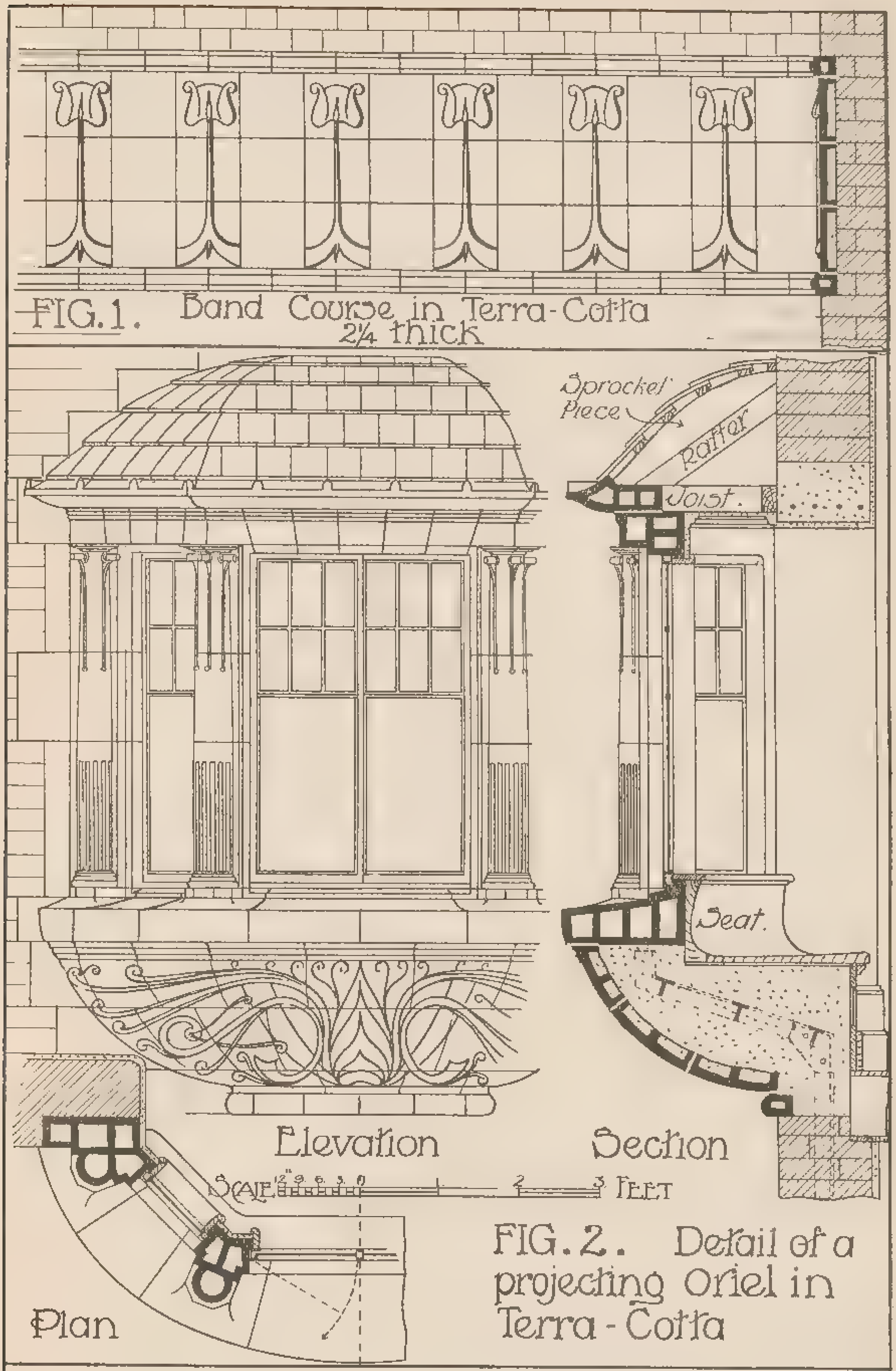


FIG. 2. Detail of a projecting Oriel in Terra-Cotta

TERRA-COTTA DETAIL.

TERRA-COTTA LUMBER.—A material of useful service in the building of partitions, the incasing of girders, and other structural steel work, is terra-cotta lumber; this material is manufactured from clay earth mixed with sawdust. It is usually made hollow, and being light in weight compared with ordinary brickwork, is often used in upper floor partitions. The stock size of blocks is usually about 12 in. x 6 in. x $4\frac{1}{2}$ in.

Oriel Window Design.—An upper-storied, projecting oriel window in terra-cotta is shown in Plate LIX., fig. 2. Here the whole of the external work is constructed of terra-cotta, being in workable pieces fitting together, back-filled with cement, and hooked, cemented, and jointed together.

The overhang below is carried on a light tee steel frame built into the solid wall below, and with cantilever pieces directly under outside corners, laced across to form a reinforcement for concrete filling, which acts as a core for the work. This core is outside lined with enriched terra-cotta, the wide weathered sill resting on top. Upon the sill the mullions are built, in three height pieces, shaped outside as three-quarter columns, and having rebatings for iron casement frames. Above is a lintel with radiating joints, surmounted by a cornice.

The roof is constructed of timber, covered with shaped tiles, hung and wired to battens. All around, next the wall, the terra-cotta is tailed into brick courses to break bond.

FAIENCE.—Faïence is of the same general nature as terra-cotta, save that it is usually glazed and colored in single or in varying tints.

The first process in the manufacture of faïence is the making of what is technically known as the body or "biscuit." This is first made and burnt similarly to terra-cotta, the colors and glazes being produced by subsequent added colorings and firings.

Faïence is used both for outside and inside purposes, and is specially suited to combine with glazed tiles for wall surface decora-

tions. Some very beautiful effects may be obtained in this medium, the effect of modelled work being greatly enhanced by the permanent glaze and the richness of reflecting light and color. These effects are most lasting, and show practically no wear. They are also peculiar in that they vary with every phase of reflected light or the position of the spectator.

Plate LX. shows a sheet of faïence details.

In faïence work absolute accuracy of line should not be expected. The character of the work is such that slight irregularities must occur, and these, together with the guttering and varied density of colored glazing, create certain effects peculiar to the material.

Faïence is set in a similar way to terra-cotta.

Tiles.—Tiles are manufactured from clay earths, and are made in Australia in a great variety of sizes, colors, shapes, and qualities.

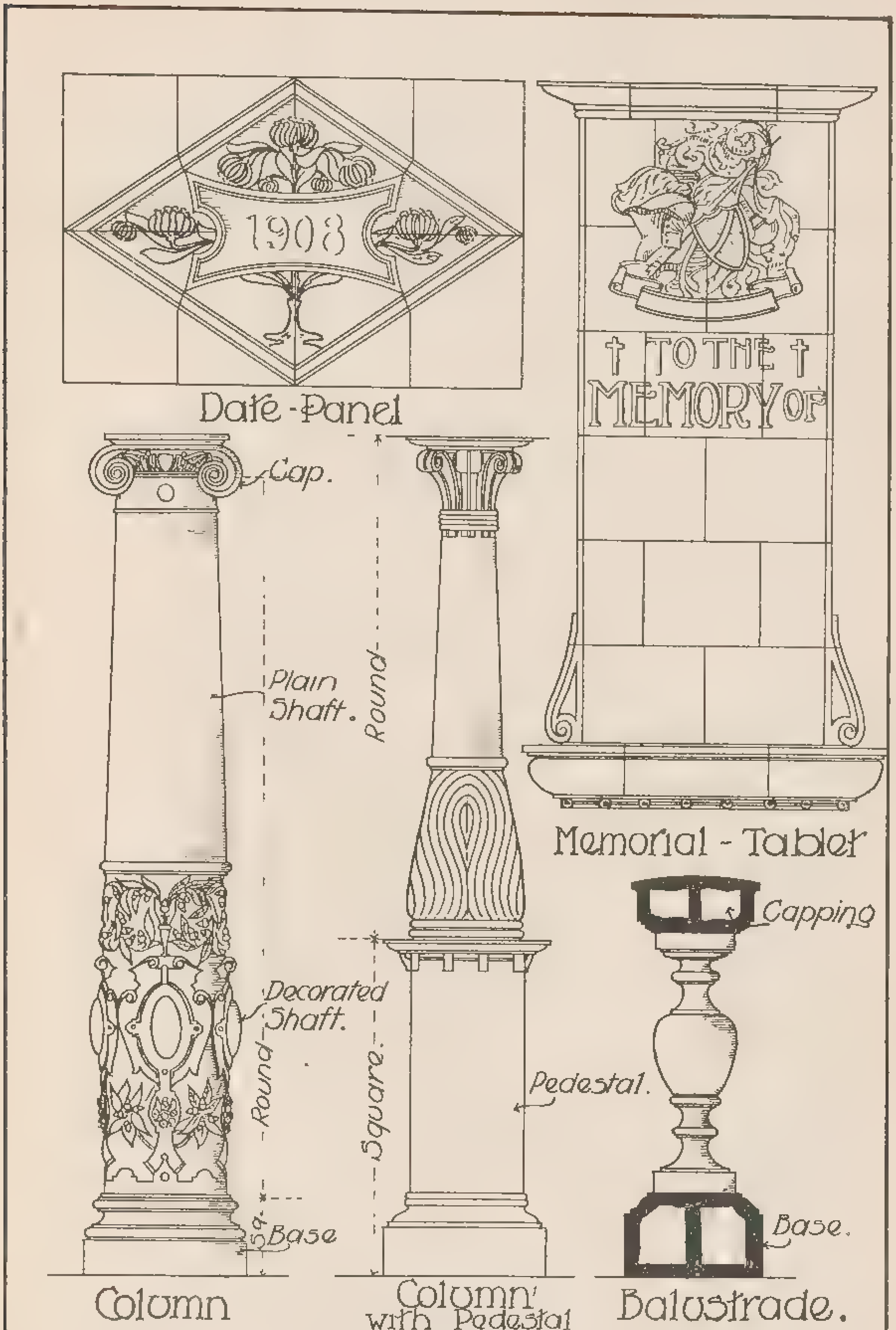
Tiles, unlike terra-cotta or faïence, are made from dust, clay earth in the form of dust being pressed into metal dies, forming the body of the tile, which is then air-dried and baked.

Floor Tiles.—Tiles for floors should be thicker and harder than those for walls; they also require to be unglazed. Floor tiles are either plain or encaustic. Plain tiles are of one color throughout. Encaustic tiles show inlay pattern in two or more colors. This pattern is made by the insetting of different clays, which, when baked, produce each its own peculiar color.

Wall Tiles.—Tiles for walls are invariably glazed, the body or biscuit being made first and the glazed outer surface put on afterwards. Wall tiles should have lock backs to form key for cementing.

Majolica Tiles are also used upon wall surfaces. They are similar in general make to ordinary glazed tiles, save that they show raised or embossed decorative face treatment.

Special Shaped Tiles.—To work and fit in with tile work, a large number of specially shaped tiles are now manufactured for rounded internal and external angles, stops, moldings, &c.



FAÏENCE DETAILS

Majolica Fenders, or fire-place curbs, are strips and angles of molded or ornamental glazed ware, to take the place of metal fenders for fire-places.

Tile-laying.—Tile-laying is one of the skilled trades. For this work a mortar compounded of slow-setting Portland cement and reasonably fine, sharp, clean sand is required. Tiles may be cut with a chisel and ground upon a stone with sand and water to a smooth face. In cutting glazed tiles the glaze has to be skilfully chipped along the line of fracture before the body is dealt with. Some tiles may be cut in the same way as glass, with a diamond.

Tile Beds.—Floor tiles should be laid on a good bed of fine cement concrete.

Wall tiles may be laid directly on to brick or stone work, or the surface may be first rendered in cement to receive them. All tiles should be soaked in water before use.

Floor Tile-laying.—Floor tiles are sometimes laid to falls, as in bathrooms, dairies, &c. In such cases the beds have to be arranged accordingly, a fall of about 1 in. in 10 ft. being sufficient, but, whether to falls or level, they should be laid on concrete, which should be first of all well wetted, so that it may not suck out the moisture from the subsequent work. A rendering of cement and sand, three to one, should then be laid in and levelled smooth. Upon this rendering the tiles are fitted, matched, and laid with close joints. In this process the tiles should upstand about one-eighth of an inch above the final level required. They should then be beaten down into the cement the full one-eighth of an inch. The next process is to grout the joints by running in liquid cement, the top surfaces being afterwards overlaid and rubbed clean with sawdust, which absorbs the superfluous grout.

Wall Tile Setting.—Long wooden battens, called screeds, require to be temporarily laid down, from which to work the true planes in tile-setting, as in plastering. These screeds are tacked at suitable distances apart, so that a straight edge or rule working upon the

top surfaces determines an even plane, thus avoiding hollows or bulgings.

Wall tiles are first well spread or buttered with cement, and then pressed into position. Each tile should be fully charged with water, though not so as to show water on the surface. This prevents the porous body of the tile from absorbing the moisture out of the cement too quickly. The mortar should be used somewhat stiff, and well pressed to the hollow, locked back of the tile.

Majolica Setting.—In setting majolica work such as fenders, moldings, &c., the work is often hung upon large-headed galvanized roofing nails, or galvanized iron wall hooks; these form a key, and fitting into the hollow, rough backing, enable the cement to obtain a firm hold upon the work.

CHIMNEY POTS.—Chimney pots are manufactured in terra-cotta in a great variety of sizes, shapes, and patterns; they are specially suited as a finish to chimneys in domestic brick architecture.

Pots should be selected of suitable sizes for flue covering, and, as the ordinary pot is generally round and the flue square, the work should be gathered over from square to round, so as not to leave any sharp obstruction where a sweeping machine may prise off the pot or shake the work.

Setting.—Chimney pots require to be deeply bedded and set in cement mortar, the outside surfaces being steeply weathered or "flaunched" off to the outside edge of the chimney.

SANITARY WARE.—Glazed pottery ware, if kept free from the danger of fracture, offers the very best material possible for all sanitary fitments, such as baths, sinks, W.C. pans, urinals, lavatories, and basins.

When applied to baths, the high cost is often prohibitive, but for all other of the purposes named glazed pottery ware may well be considered.

Soundness should always be looked for in pottery, which should

ring when struck. The glaze, too, should be perfect, and free from "crazing" (small cracks), as it must be remembered that only the glazed surface is impervious, the body being absorbent.

In the design of these fitments, self-cleansing should be looked for, and such inner shape and freedom from sudden corners secured as to ensure clear flushing when in use.

The old method of casing with wood should be entirely abandoned in favour of complete openness on all sides, non-rustable metal being used where supports are required.

Vents.—For terra-cotta vents, see Ventilation.

CHAPTER XIV.

STEEL AND IRON IN CONSTRUCTION.

Structural Steel.—The term "structural steel" is usually applied to beams, stanchions, &c., used for weight-bearing in floors, walls, &c.

Some of the more common forms of structural steel are illustrated on Plate LXI.

In the field of steel manufacturing the most complete information, with lists of stocks, tables of tests, calculations of weights, &c., are supplied in book form by the leading manufacturers of England and America, and through their agents are made directly available in Australia. The best of such books should be referred to by the student, as they offer, in a very exhaustive form, valuable data to work upon in carrying out actual work in structural steel, and doubly so when it is remembered that, in using steel, use is being made of a manufactured, not a natural article. The designer's attention, therefore, requires to be directed towards the best and most practical application of the stock manufactured article.

Steel Standard.—The steel in common use is that known as Siemens-Martin steel, and should be guaranteed to have an ultimate strength of from 28 to 32 tons per square inch.

Beams.—Steel beams are of various kinds, the most common being the rolled steel joist (R.S.J.), which is rolled in a very great variety of sizes and weights, and has become the most common commercial article in the market for overhead weight-carrying in permanent structures. This, together with other forms of the beam and girder, are shown in Plate LXI., fig. 1.

When acting as a beam, the ordinary R.S.J. may be sufficient

of itself, or it may require to be strengthened with top and bottom plates, as shown in the figure. Girders are often what is called "built up" —that is, made up of separate parts, mainly consisting of R.S.J. and plates, or plates, angles, &c., rivetted together (see fig. 1).

British structural steel is manufactured in accordance with what is known as "British Standard Sections"—*i.e.*, certain generally recognized sections of given form, strength, and weight are manufactured and stocked by the leading manufacturers.

These standards include sections for railway and bridge work and ship-building, as well as for the general purposes of building construction. This standardizing aims at securing a uniformity of productive value among all the leading manufacturers of British steel. The British standards include a sufficient number of sizes in the standard lists to ensure a satisfactory graduation for all practical purposes, whilst at the same time they reduce, as far as possible, the number of rolls which the steel-makers find it necessary to hold in stock.

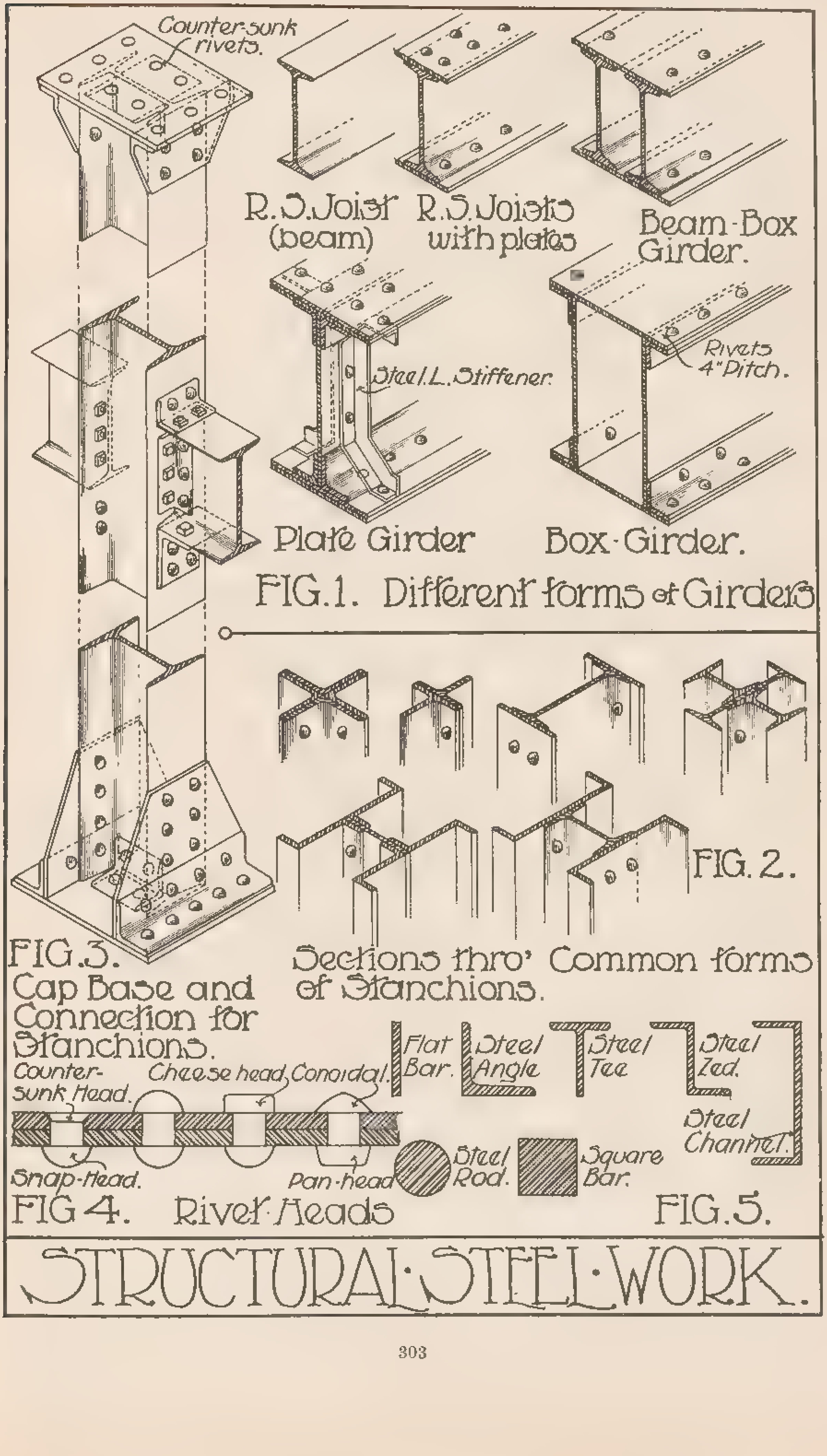
On page 302 will be found a list of British standard beams (rolled steel joists) most usually in demand in the Australian market, and gives the safe distributed load each joist will carry. As a rule in a building the depth of a steel beam should at least equal one-twentieth of the span, so as to avoid any undesirable amount of deflection—*i.e.*, sagging of the beam in the centre. The figures above the zig-zag line in the table secure this. Where loads are unequally distributed they have to be calculated for separately.

In ordering structural steel it is desirable that all materials be ordered by weight per lineal foot, in combination with the over-all dimensions.

American steel beams will be found to differ somewhat in size and weight of rollings from the British standard, as the larger producers of American structural steel have their own range of standards, suited to the normal requirements of their own trade.

Safe Distributed Loads on British Standard R.S.J. in Tons, with a Safety Factor of 4.

Size of Joists in Inches.	Weight per foot. Lbs.	LENGTH OF SPAN IN FEET. 4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
24 x 7½	100				102	92	79	69	61	55	50	46	42	39	36	34	32	30	29	27
20 x 7½	89			94	83	69	59	52	46	41	38	34	32	29	27	26	21	23	22	20
18 x 7	75			78	64	53	45	40	35	32	29	26	24	22	21	20	18	17	16	
16 x 6	62		73	56	45	38	32	28	25	22	20	19	17	16	15	14	13	12	11	
15 x 6	59		62	52	42	35	30	26	23	21	19	17	16	15	14	13	12	11		
15 x 5	42		47	35	28	24	20	18	16	14	13	12	11	10	9.5	9	8.4			
14 x 6	57		59	47	38	31	27	24	21	19	17	16	14	13	12					
14 x 6	46		43	39	31	26	22	19	17	15	14	13	12	11	10					
12 x 6	54		52	39	31	26	22	19	17	15	14	13	12	11	10					
12 x 6	44		40	33	26	22	19	16	14	13	12	11	10	9						
12 x 5	32		30	23	18	15	13	11	10	9	8.3	7.6	7	6.5						
10 x 8	70		53	43	34	28	24	21	19	17	15	14	13							
10 x 6	42		35	26	21	17	15	13	11	10	9.6	8.8	8							
10 x 5	30		24	18	14	12	10	9	8	7.2	6.6	6	5.6							
9 x 7	58		42	32	25	21	18	16	14	12	11	10	9.8							
9 x 4	21	22	15	11	9	7.5	6.4	5.6	5	4.5	4	3.7								
8 x 6	35	31	23	17	14	11	9.8	8.6	7.7	7	6.3									
8 x 5	28	25	18	14	11	9	8	7	6.2	5.5	5									
8 x 4	18	17	11	8.7	7	5.8	5	4.3	3.8	3.5	3.2									
7 x 4	16	14	9.4	7	5.6	4.7	4	3.5	3.1	2.8	2.5									
6 x 5	25	18	12	9	7.3	6	5.2	4.5	4											
6 x 4½	20	14	9.6	7.2	5.8	4.8	4.1	3.6	3.2											
6 x 3	12	8.4	5.6	4.2	3.4	2.8	2.4	2.1	1.9											
5 x 4½	18	11.3	7.6	5.6	4.5	3.8	3.2	2.8												
5 x 3	11	6.8	4.5	3.4	2.7	2.3	1.9	1.7												
4¾ x 1¾	6.5	3.5	2.4	1.8	1.4	1.2	1													
4 x 3	9.5	4.7	3.1	2.3	1.9	1.6	1.3													
4 x 1¾	5	2.3	1.5	1.1	.91	.76	.65													
3 x 3	8.5	3.2	2	1.6	1.2	1	.9													
3 x 1½	4	1.4	.92	.6	.55	.46	.39													


Counter-sunk rivets.
R.S.Joist (beam)
R.S.Joists with plates
Beam-Box Girder.
Steel L. Stiffener.
Rivets 4" Pitch.
Plate Girder
Box-Girder.
FIG.1. Different forms of Girders
FIG. 2.
Sections thro' Common forms of Stanchions.
FIG.3. Cap Base and Connection for Stanchions.
Counter-sunk Head.
Cheese head, Conoidal.
Snap-Head.
Pan-head
FIG 4. Rivet Heads
Flat Bar.
Steel Angle
Steel Tee
Steel Zed.
Steel Channel.
Steel Rod.
Square Bar.
FIG.5.
STRUCTURAL·STEEL·WORK.

Uprights.—Cast-iron columns are sometimes used to support independent beams. Where steel is employed the uprights are called "stanchions." These are made in a variety of different ways to suit the work required of them, several typical forms being illustrated in Plate LXI., fig. 2.

An illustration is also shown in the same figure of an H section stanchion, with base cap and intermediate connections, a type of upright often used to take the weight of several floors, one above the other, in warehouse or factory work. (Plate LXI., fig. 3.)

Connections.—The connections in structural steel are highly important, and should be so arranged as to give full efficiency by the simplest, strongest, and most direct methods. The work, too, requires to be done, as far as possible, in the engineering shop, and in such a way as to be the most easily assembled upon the site and readily and cheaply fixed.

It is important that the ends of all beams used as stanchions should be machined true and square, so as to give even and fair bearing.

Connections are usually made by rivetting, of which the various kinds are shown in Plate LXI., fig. 4. The size of the rivets and their distance apart, the finish of the heads, and whether hand or machine rivetting is to be employed, should all be mentioned in the specification, as also whether the holes are to be drilled or punched. Where smooth fair bearings are required countersunk flush rivetting is necessary.

For secondary connections bolts and screw nuts are sometimes used in place of rivets.

For making connections and for stiffening, angle and tee steel is mostly used, as such forms lend themselves most readily to the work required.

Several of the common forms in which steel is manufactured for various purposes are shown in Plate LXI., fig. 5.

Protection and Preservation.—All structural steel work should be cleaned from rust and painted with red oxide paint in every part,

both in the shop and after it has been fixed. The damaging effect of fire upon steel is well known, as under intense heat steel will readily buckle and twist, and not only destroy its own efficiency, but in its fall tear down and destroy other parts of a structure. To guard against this structural steel is sometimes cased in with interlocking terra-cotta made for the purpose, or otherwise cased in asbestic material. Such methods, however, add considerably to the cost of the work, and are not commonly used.

Where fire-proofing is required some form of reinforcing is now usually employed (see Chapter XII.)

Steel Roofs.—Upon the lower portion of Plate LXIX. a variety of types of steel roof principals are shown for spans of from 30 to 80 ft.

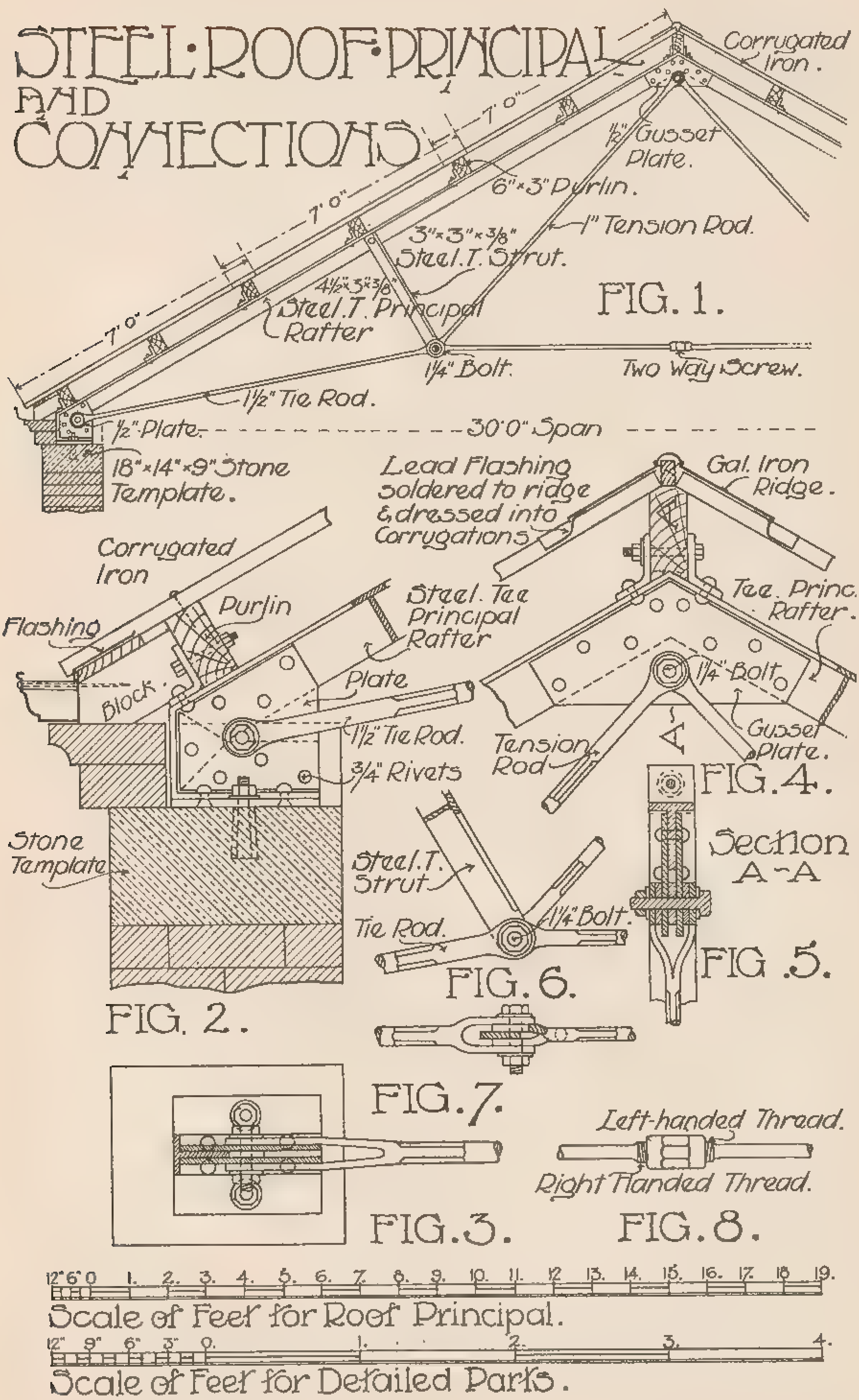
Such principals require to be designed to carry the weight of the roof covering, the purlins, and the principal itself, together with the load likely to be added by wind pressure.

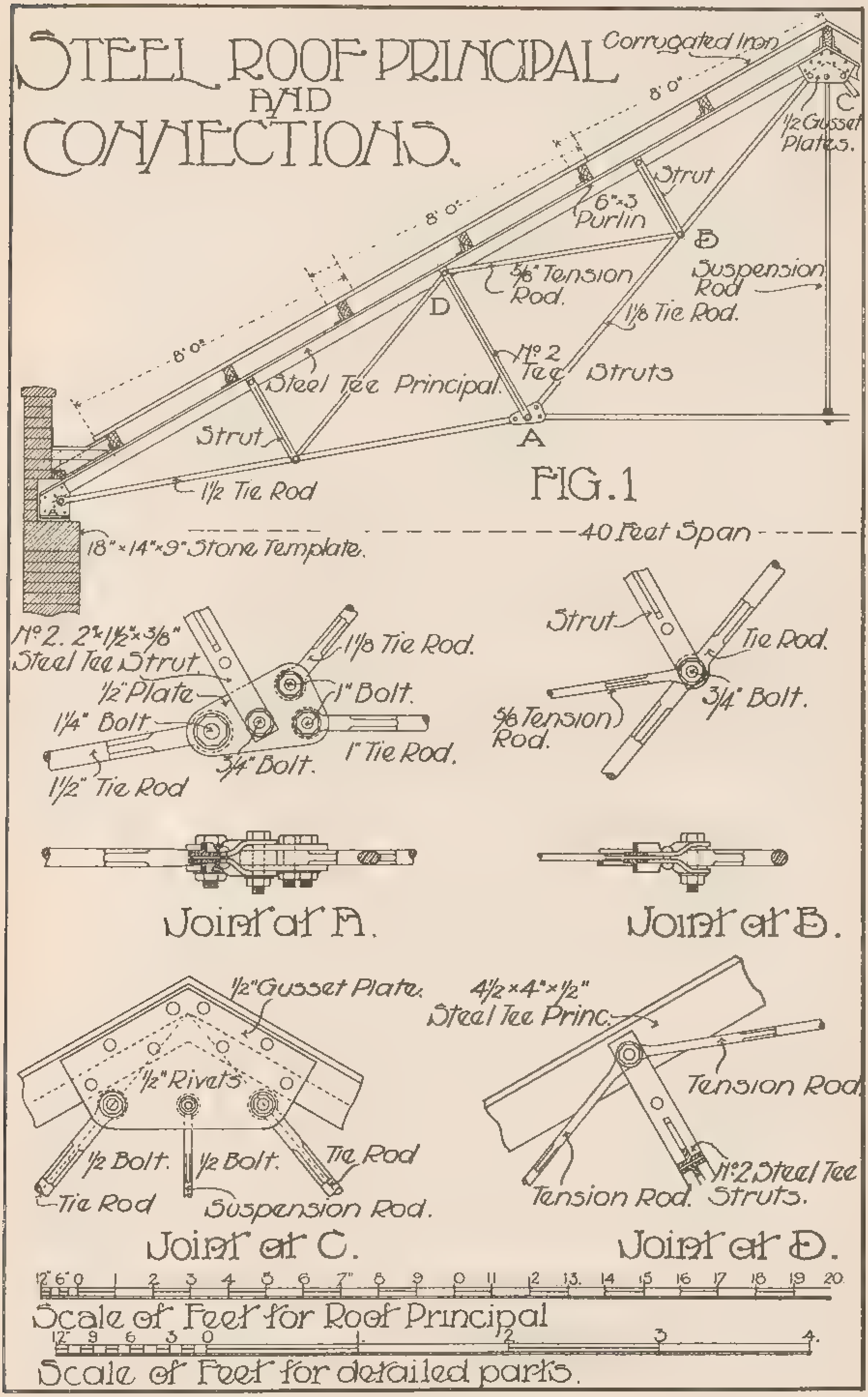
In the construction of principals, the main forces of compression and tension have chiefly to be allowed for, and it should be noted that in the plate the compression members are shown by thick lines, and the members taking up the tension strains by thin lines.

In Plate LXII. a steel principal for a span of 30 ft., with principals 9 ft. apart, is shown in detail, the parts and connections being very fully illustrated by enlarged drawings, which should be carefully followed.

It will be noticed that the roof covering is of corrugated iron, which is secured to wooden purlins, spaced at suitable distances apart and secured to the rafters with angle pieces. The principal is constructed of tee steel rafters, connected at apex, and held with plates and stiffened with tension and tie rods. There is one tee strut on either side. The enlarged details show how the various parts are forged, cut, fitted, bolted, and rivetted together.

Fig. 1 shows the general elevation of the principal, with section through wood purlins and brick wall. Fig. 2 is the enlarged detail


STEEL·ROOF·PRINCIPAL AND CONNECTIONS
Corrugated Iron.
7'0"
7'0"
7'0"
7'0"
½" Gusset Plate.
6"×3" Purlin.
1" Tension Rod.
3"×3"×⅜" Steel.T. Strut.
4½"×3"×⅜" Steel.T. Principal Rafter
FIG. 1.
1¼" Bolt.
Two Way Screw.
1½" Tie Rod.
½" Plate.
30'0" Span
18"×14"×9" Stone Template.
Lead Flashing soldered to ridge & dressed into Corrugations
Gal. Iron Ridge.
Corrugated Iron
Purlin
Flashing
Steel. Tee Principal Rafter
Tee. Princ. Rafter.
Block
Plate
1½" Tie Rod.
1¼" Bolt
3/4" Rivets
Tension Rod
Gusset Plate.
A
FIG. 4.
Section A-A
Stone Template
Steel.T. Strut
Tie Rod.
1¼" Bolt.
FIG. 5.
FIG. 6.
FIG. 2.
FIG. 7.
Left-handed Thread.
Right Handed Thread.
FIG. 3.
FIG. 8.
12" 6" 0 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19.
Scale of Feet for Roof Principal.
12" 9" 6" 3" 0. 1. 2. 3. 4.
Scale of Feet for Detailed Parts.


STEEL ROOF PRINCIPAL AND CONNECTIONS.
Corrugated Iron
8' 0"
1/2 Gusset Plates.
C
Strut
6"×3 Purlin
B
5/8" Tension Rod.
Suspension Rod
D
1 1/8 Tie Rod.
No 2 Tee Struts
Steel Tee Principal.
Strut
A
1 1/2 Tie Rod
FIG. 1
40 Feet Span
18"×14"×9" Stone Template.
No 2. 2 3/4×1 1/2×3/8" Steel Tee Strut
1 1/8 Tie Rod.
1/2" Plate
1" Bolt.
1 1/4" Bolt
3/4" Bolt.
1" Tie Rod.
1 1/2" Tie Rod
Strut
Tie Rod.
3/4" Bolt.
5/8 Tension Rod.
Joint at A.
Joint at B.
1/2" Gusset Plate.
1/2" Rivets
1/2 Bolt.
1/2 Bolt.
Tie Rod
Tie Rod
Suspension Rod.
Joint at C.
4 1/2×4"×1/2" Steel Tee Princ.
Tension Rod
Tension Rod.
No 2 Steel Tee Struts.
Joint at D.
Scale of Feet for Roof Principal
Scale of Feet for detailed parts.

of the wall seating, fig. 3 being the plan of same, showing how the bottom plate is rag-bolted down into a stone templet. Fig. 4 is the detail of the meeting of the two rafters at the apex, fig. 5 being the section through the same. Figs. 6 and 7 show the junction of a strut with the tie and tension rods, and how they meet and are bolted together. Fig. 8 shows the method adopted, by means of a screwed coupling joint, for tightening up the tie-rod—a device which is sometimes placed in tie-rods likely to require length adjustment.

Plate LXIII. illustrates another type of steel principal, which may be used for roofs having a clear span of from 40 to 80 or even 100 ft. if proper increased sizes be added to the metal. Fig. 1 shows a roof suitable to a 40-ft. span, with corrugated iron covering and timber purlins, the principals being 9 ft. apart. In this case a parapet gutter is shown. By following the enlarged details it will be seen how the various joints and connections of parts are arranged.

As steel roofs are usually adopted for large spans, and specially for extensive roof area, they are the more readily acted upon by wind pressure. They, therefore, require, both for this reason as well as on account of the nature of the material itself, to be carefully braced.

Bracing in an elastic, non-rigid material like steel is in the very highest degree important.

In addition to the principals, which, of themselves, constitute a braced weight-carrying framework, a steel roof is usually stiffened, and the whole roof made rigid, by the introduction of some form of lateral bracing.

Steel Escape Stairs.—Steel fire escape stairs are extensively employed in large business and public buildings, especially in positions where they may be arranged to offer an emergency means of escape.

These stairs are usually made of steel. A design, with some

details of such a stair, is shown on Plate LXIV. The perspective shown is of a one-flight stair only, but the principle here illustrated may be extended to more complicated stairs and overhead escape ways.

The diagram shows the strings, landing, and treads of boiler plate. The treads and landings are usually bob punched—that is, dented upwards from below with a round-headed punch at intervals, so as to offer a rough surface to the tread. The enlarged drawing shown upon the upper part of the plate should be carefully studied for details of parts and how they are put together.

Cast Iron.—Cast iron is used for columns, railings, gates, and to a large extent in verandah and balcony columns, also for shoes and heads in heavy timber roofing, and in many other ways. Its disadvantage is its brittleness and its serious liability to fracture under a sudden and heavy blow.

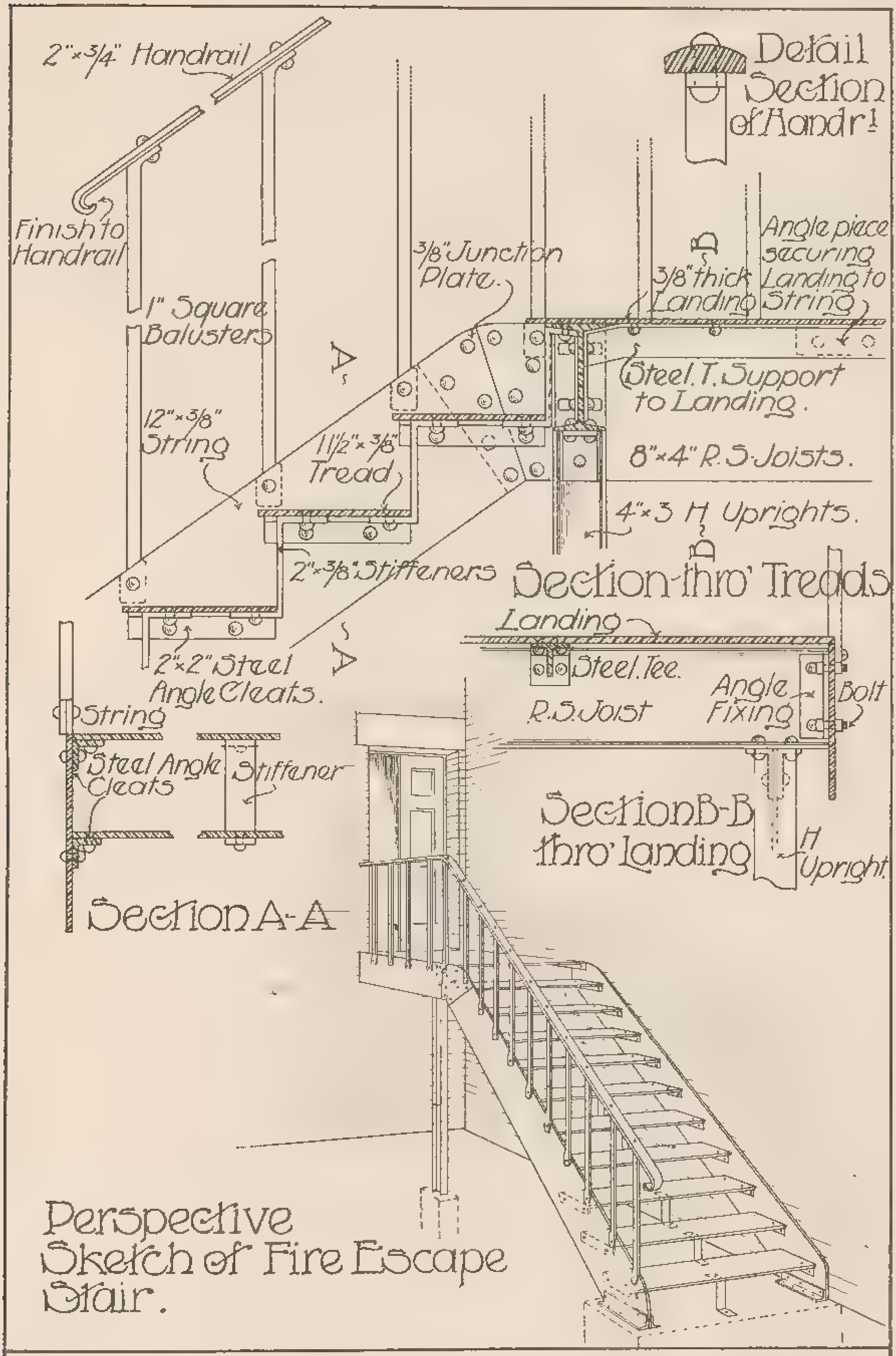
Any number of castings may, however, be made from the same pattern in cast iron, which gives facility for the ready repetition of the various parts of any work produced in this medium.

Castings are produced from "patterns," which are duplicate copies of the articles required, usually made of wood in parts to suit the work, and of sizes to allow for shrinkage.

These "patterns" are laid in sand tightly rammed to the shape of the pattern. This is called "molding." The molds are so arranged that the pattern may be withdrawn, leaving the true impression in the hard, smooth sand. Vent holes for the steam are left, and pouring gutters provided. The molten metal is poured into the gutters and allowed to cool, after which the sand is removed, the rough burrs at the junction of the molds chipped off, and the casting made ready for use.

For work such as furnace fire-boxes, cast iron withstands excessive heat much better than wrought iron or steel, and is therefore to be preferred when next to fire.

Wrought Iron.—Architectural wrought iron is one of the



FIRE ESCAPE STAIR

mediæval crafts, with which much interesting Old World craftsmanship is associated, and of which there has been a considerable revival in modern times.

This kind of ironwork is applied to building of the highest class, and, being all hand wrought, may be designed and executed in such a way as to give greatly added value to any work of which it forms a part, such as in railings, gates, grilles, guards, hinges, door knockers, bell pulls, internal furniture, &c.

The strength, together with the malleability and ductility of iron, renders it specially serviceable and suitable for use in work of this description, and when it is conventionally treated, and so shaped and wrought as to display the marks of the hammer and the mode of its production, few materials, if any, can vie with it in that subtle blending of utility with beauty that constitutes true applied art.

CHAPTER XV.

CARPENTRY AND JOINERY.

Generally.—The craft of timber-working for building purposes is classed either as "carpentry" or "joinery," cabinet-making being an allied craft which deals more especially with furniture.

The line of demarcation between carpentry and joinery is not easily definable, as the scope of the one trespasses at times very closely upon the province of the other. Carpentry should, however, be understood to include all those more structural portions of the woodwork of a building, carried out for the most part upon the actual structure itself, such as floors, roofs, timber framing, wood partitions, and structural work generally, while joinery embraces all the "shop-made" woodwork, such as windows, doors, frames, fittings, stairs, linings, panellings, moldings, fitments, &c., and their fixing and finishing upon the actual work.

Wrought and Unwrought.—A broad division is always made in a building between the wrought—*i.e.*, planed—and the unwrought timber, and a covering clause may be inserted in specifiying somewhat as follows :—"All work exposed to view to be wrought to one even and smooth surface throughout."

Speaking generally, the "structural" timbers are invariably left rough from the saw, but in the case of open timber roofing or exposed rafter ends such timbers are wrought in the usual way.

STRUCTURAL TIMBERS.—"Structural timbers" require to be of a different nature from "finishing timbers" and this brings us to a

workable division of the available timbers in the Australian market —"structural timbers" and "finishing timbers."

In speaking of timber it should be remembered that a division must be made between what may be described as "timber in theory" and "timber in practice."

To enter into the great variety of timbers to be found in various parts of Australia is not necessarily to find such a variety actually existent upon the working market. Doubtless as time goes on our timber resources will be more largely developed and more scientifically cut, seasoned, and made available. For our present purpose it is, however, more practical to deal with those timbers that are commonly available, both local and imported. These may be enumerated somewhat as follows:—"Structural timbers"— Oregon, hardwoods, jarrah, red gum, Murray pine, Pacific pine, &c.

Of these Oregon is the best (imported) structural timber we have. It is excellent for all general purposes and reliable for first-class work.

The hardwoods are numerous, and are suitable for rough and cheap work, where twisting and shrinking does not seriously matter. They require, however, to be kept out of the ground, otherwise their decay is rapid. Generally speaking, the red Australian timbers are the most durable.

Jarrah is a well-known Western Australian timber, used for structural as well as for finishing purposes. It is heavy and dense and stands exposure well.

Red gum is hardly suitable for structural work, its use being chiefly confined to work in or near the ground, such as stumps, plates, fence posts, &c. In such positions it lasts well.

Both Murray and Pacific pine are used in limited degree for the cheaper class of work, in districts where it is easily made available.

Other structural timbers are employed in various parts of Australia, but these are chiefly confined to local rather than to general use.

FINISHING WOODS.—The following is a list of finishing woods :—

TIMBER.	REMARKS.
Red Californian Pine (Redwood)	Excellent for all outside finishing purposes, such as barges, half-timbering, &c. Good, though soft, for joinery.
Red Deal	For all general frames, joinery, &c. (requires painting).
Baltic flooring, lining, and weather-boards	Universally used.
Kauri (New Zealand)	For joinery, flooring, doors, linings, &c. One of the most valuable for joinery purposes.
Hoop Pine (Queensland)	Doors and joinery, &c. Takes stains well.
White Pine (New Zealand) ..	Shelving, &c.
Clear Pine	For highest class painted joinery.
Blackwood	All excellent finishing woods if dry and well seasoned.
Boligum	
Silky Oak	
Huon Pine	
Beanwood	
Colonial Beech	
Jarrah, &c.	
Oak	Suitable for fittings and highest class finishings.
Ash	
Cedar	
Walnut, &c.	

THE PREPARATION OF TIMBER.—Timber for all general building purposes is now held in stock, or cut by the leading timber merchants into sizes to suit the trade.

In selecting care should be exercised towards choosing only timber that is well grown, free from sapwood (which readily decays), large, dead or loose knots, cracks, gum veins, or similar imperfections—timbers, too that have been scientifically cut from the log so as to shrink fairly, and so dried as to be straight, true, and workable.

It is well, at the outset, to remember that each class of timber has its own limit of usefulness, and hence the various devices of carpentry and joinery are constantly being exercised towards using each class of timber as best suits its nature and character. For example, some timbers cut to good bulk and are solid for weight-

bearing; others may be had in long lengths, with tenacious quality, for spanning across in floors and roofs; yet others are short in grain, and are only obtainable in contracted widths or limited lengths, and these may be suitable for joinery or finishing purposes, so that, whatever the nature of the wood, if it be but sound and of good quality, it may find its use in some part of builders' work.

It is interesting to note how this sort of thing is constantly influencing constructive methods. A door, for instance, may not be made of one board; hence the device of framing and panelling. A beam is only obtainable in a certain length, hence the need for scarfing, and so right through. The end grain shrinking of certain timbers, the buckling tendency of others, as well as the degree of external finish obtainable, is both making and changing present day work in no small degree, so that both in the design of woodwork and in its practical execution much skill needs to be exercised.

Shopwork.—The former method of builders making their own joinery tends strongly to become obsolete, for the manner now adopted of having this class of work made in large joinery establishments attached to the yards of timber merchants gives rise to the free use of machinery, and produces quicker if not more substantial work than by the older hand methods of former days. Joinery then, as is so specially true of an ever-increasing number of things in the modern building, tends more and more to become an ordinary purchasable quantity. Large stocks of ready-made doors, windows, verandah posts, pickets, architraves, skirtings, moldings, &c., are now held, and may be drawn upon for ordinary work; the better class of work only being made specially to design.

In joinery finishing, as in all finishing, the nature of the finish required should be specially defined, as a "painted" finish is much more roughly executed than work for a "polished" finish, the latter requiring secret tenoning, secret nailing, hand-dressing, and sand-paper finishing, whereas with the former a good, sound, clean finish, with nails well punched in, will be found sufficient.

The Preservation of Timber.—Timber requires not only to be specially selected so as to be suitable for the work required in the various positions where it may be used, but it must also be preserved from dry and wet rot. Dry rot occurs where timber is kept without air; the free circulation of air, therefore, is essential for the preservation of all structural timbers. Wet rot occurs the most readily in the imported pine timbers, and these require to be kept out of the ground and well painted, only timber capable of withstanding wet being allowed in exposed positions.

To place timber actually in the ground or at the junction of the ground with the air, is the most severe test, and leads rapidly to the decay of all timbers save a very few, of which are—red gum, jarrah, Huon pine, and a few others.

Joints and Fixings.—In carpentry the making of suitable joints and connections between the various timbers is of the greatest importance, and such jointing should be so managed as to throw as little work upon the actual nailing as possible.

The names of the common joints in carpentry are housing, halving, notching, bird's-mouthing, cogging, mortising and tenoning, scarfing, checking, heel-jointing, &c.

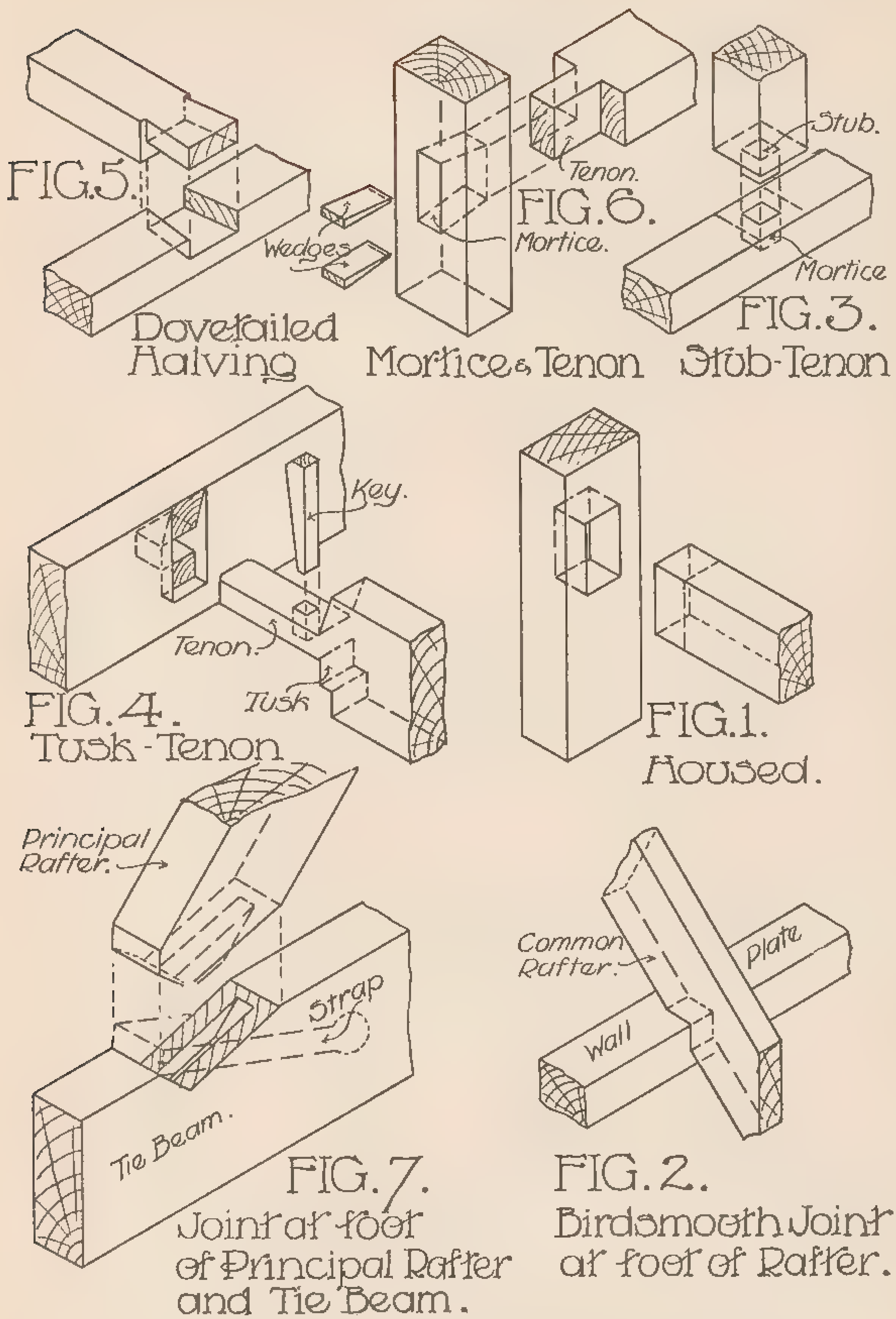
Housing (Plate LXV., fig. 1) is where the end of one piece of timber is sunk in its entirety into another piece set at right angles.

Halving in its various forms is shown in Plate LXVI., figs. 1, 2, and 3, and Plate LXV., fig. 5. Halving is mostly used in the laying and connection of plates.

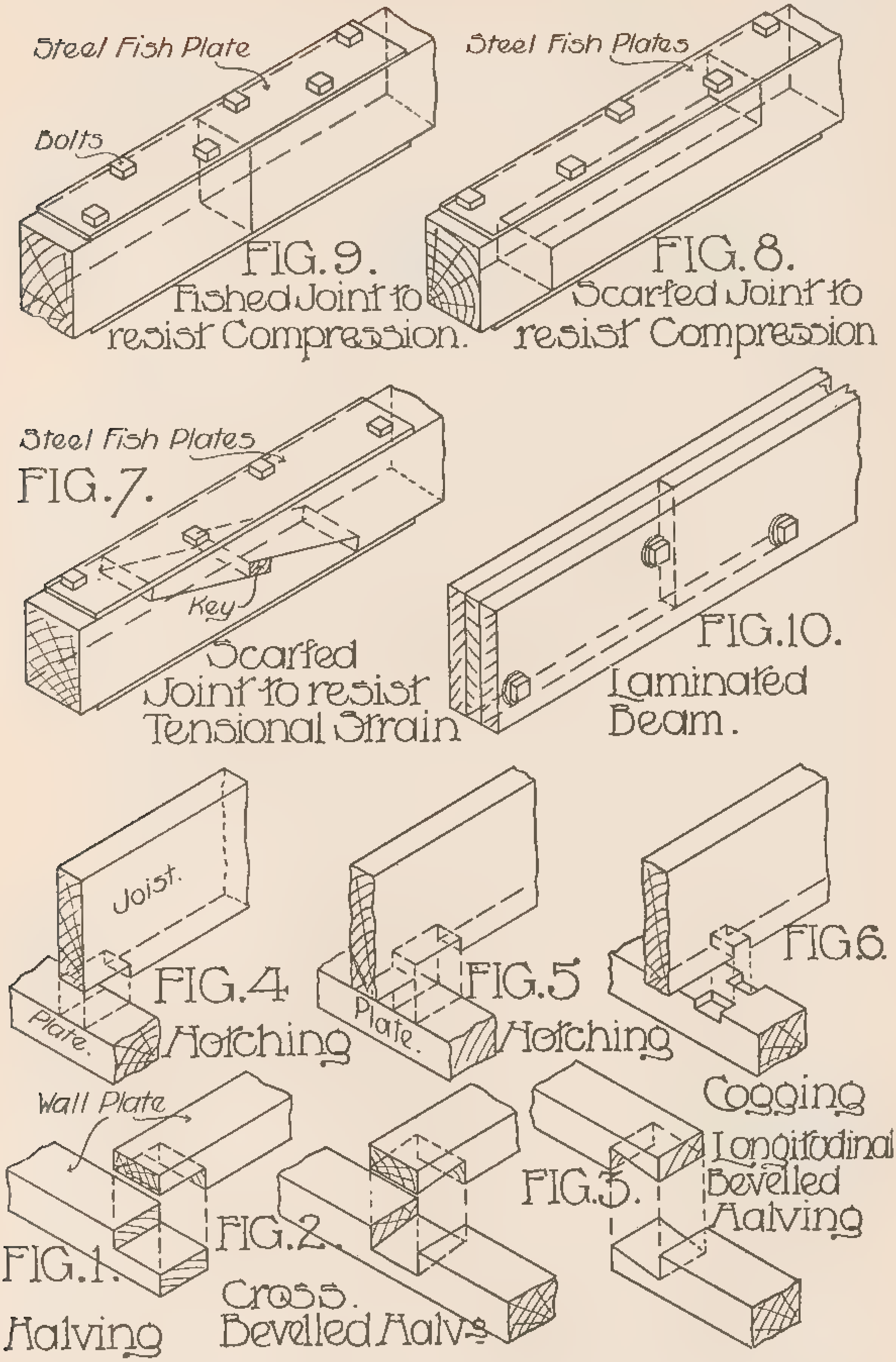
Notching.—Two forms of notching are shown on Plate LXVI., figs. 4 and 5. These show notching applied to joists resting upon plates, as in a floor.

Bird's-Mouthing.—Another form of notching is the "bird's mouth" (Plate LXV., fig. 2). This, in various forms, is applied to rafters resting upon wall plates.

Cogging is a more elaborate kind of notching. (Plate LXVI., fig. 6.)



JOINTS IN CARPENTRY



JOINTS IN CARPENTRY.

Mortising and Tenoning is carried out in various ways, the simplest form being the "stub tenon." (Plate LXV., fig. 3.) This is where an upright piece of timber—say a "stud"—is tenoned into a plate. The upright end is squared and cut away, all save a portion of the centre called the tenon; a hole, the "mortise," corresponding to the tenon, is then sunk in the plate to receive the tenon. This is mortising and tenoning. A simple mortise and tenon is shown in fig. 6. Other forms are the "tusk tenon" (Plate LXV., fig. 4), used in the trimming of joists. In this the tenon has to supply a seating. The long end, passing right through the mortise, is wedged up with key upon the other side. See its application to upper floor fire-place in Chapter X., Plate XLVIII., fig. 4.

Other forms of the mortise and tenon, but as applied to joinery, are shown on Plates LXXX. and LXXXI. (doors).

In cabinet work, and occasionally in joinery, what is known as "fox-tail wedging" or "secret tenoning" is applied to mortising. This consists in making the mortise dovetailed shape, and inserting wedges in the ends of the tenon before it is driven home. This is to prevent the tenon from showing through the work, such as to door styles, &c., and is used in the best class of work where visible tenons are otherwise commonly used.

Scarfing is necessary where timbers cannot be obtained of sufficient length for the purpose. Scarfing is the joining of timbers in the direction of their length, and is shown in Plate LXV., figs. 7, 8, and 9.

Checking is a term applied in a general way to various connections of timbers, one fitting into the other, such as at the junction of a strut with fence post and sole plate. (See Plate LXXVI., figs. 1 and 2.) This check gives to the work a rigidity, independent of the nailing, and is very generally used throughout carpentry.

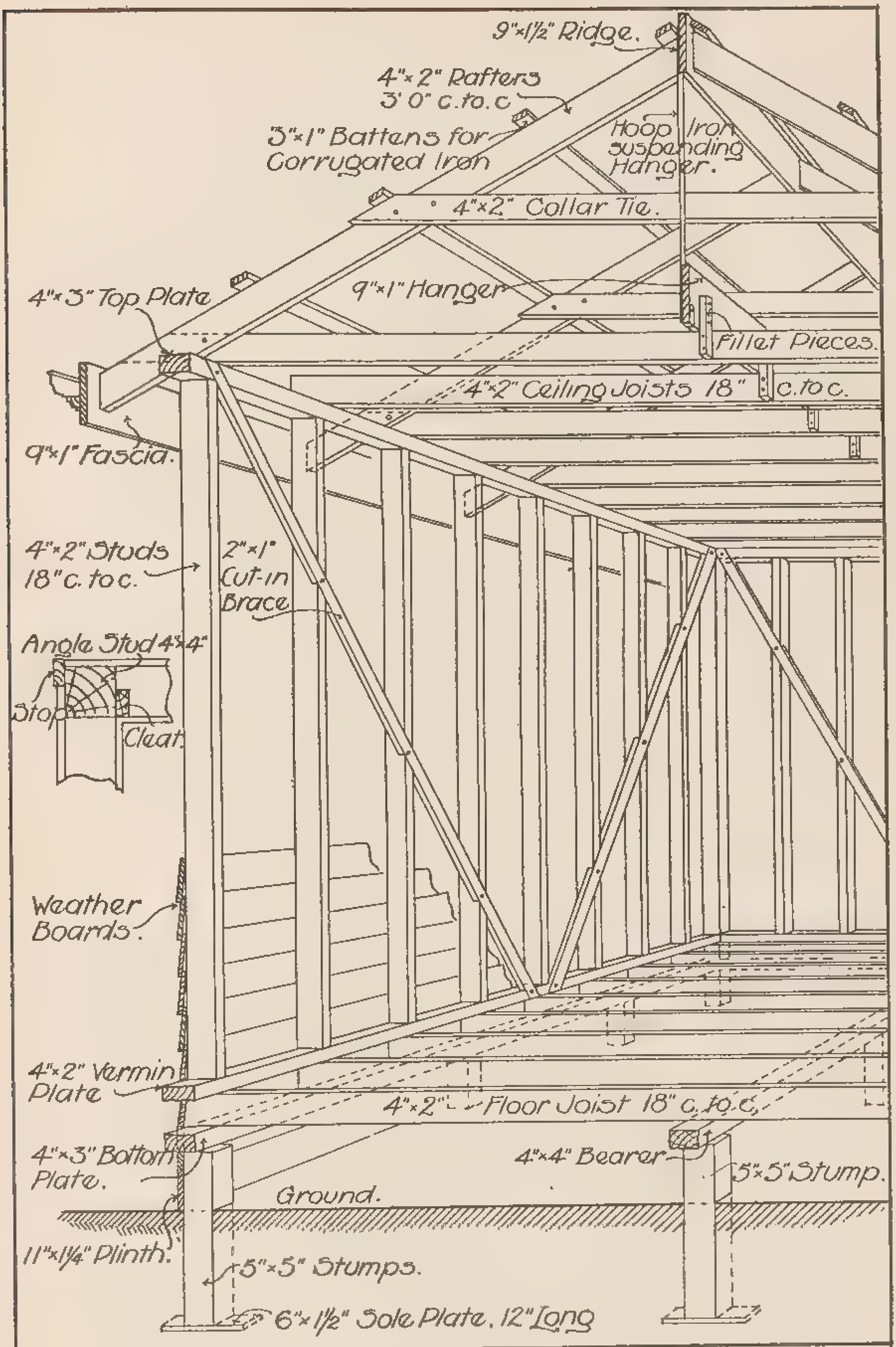
Heel-jointing, &c.—Various kinds of joints for connecting principal rafters with the ends of tie-beams are used. These consist of either plain checking or checking and tenoning, and are designed to resist shearing. A common form is shown in Plate

LXV., fig. 7. Other roof joints are shown on sheets illustrating roof principal details.

Fixings.—Wire nails of various lengths and thicknesses, sold by weight, are commonly employed for fixings in carpenters' work. Finishing nails (brads) are used in joinery and for small, neat work, also for secret nailing in floors, &c. Screws are used where special strength and clean finish are required; they are of various lengths and thicknesses, and are sold by the gross. Brass screws are employed in such work as wooden wash troughs, washable table tops, and wherever water comes into direct contact with the fixings. Coach and handrail screws are employed for special work. Bolts and nuts are used to pierce and connect timbers where special strength is required. For these holes are bored, the bolts inserted, and the nuts tightened up. Forgings in straps of various kinds are largely used in roof principal work. These are mostly made out of flat iron, forged and cut to shapes, and bolted in position. Castings are sometimes used in roof principals to form end seatings, or to act as rafter and king heads at apex of principals. Glue is more commonly used in joinery than in carpentry and for inside work; it should be clean, applied hot, and the work cramped up to allow of close setting.

TIMBER STRUCTURES.—*Wood Frame Building.*—A very large percentage of Australian building is built in timber, especially in districts where native woods are readily obtained, and even where the imported timbers have to be employed the cost of such building is so much less than brick or stone as to lead to its ready adoption.

For the best class of domestic building, where the work has to receive internal plaster, the structural timbers must be dry, otherwise serious fracture is certain to occur; to alleviate this, wood lining or stamped steel may be substituted for plaster. In store or factory building this tendency towards shrinkage is not, as a rule, so serious a disadvantage.



WOOD - FRAME BUILDING

There are several ways of constructing a frame building, but that shown on Plate LXVII. is one of the most common. Following the line of the ground plan of the walls, stumps are sunk in the ground under the walls. These must be of jarrah, red gum, or such timbers as will not readily rot. Where white ants are likely to be present, the stumps should be of such materials as will not readily be attacked by these termites, and the stumps should be coated with ant exterminator and protected on the top with galvanized sheet iron ant stops—*i.e.*, inverted sheet metal plates covering the stumps and projecting well over same. Stumps are often of unsawn timber fair cut off at top. Brick or stone piers may also be substituted, or a dwarf wall may be used instead of the pier system.

In the diagram the stumps are shown of 5-in. by 5-in. sawn timber, sunk 24 in. in the ground and resting upon 6-in. by $1\frac{1}{2}$-in. sole plates. This sole plate is not always necessary. In good soils the stumps may be sunk and driven home with a heavy maul. Stumps are generally placed at distances of about 4 ft. apart, the same system being applied to supports under floors as under walls.

Upon the top of the stumps the bottom plate (of similar timber) is laid; this is halved at joints and angles, and well spiked to stumps, similar pieces of timber being placed under floor joists, called "bearers."

The floor joists are laid upon the top of these, and for domestic work, are sufficient if of 4 in. by 2 in. hardwood, spaced 18 in. apart centres, and well skew-nailed. On top of the joists, and immediately above the bottom plate, the "vermin plate" is laid. The work of this plate is to receive the lower ends of uprights, which are called "studs;" these are either mortised and tenoned or housed and skew-nailed. For weatherboards studs require to be 18 in. apart centres. For galvanized iron covering without inside lining, a greater distance apart may be adopted, as 24 in. or 30 in. The studs rise the full height of walls, and are covered with the "top plate," into which they may be housed or tenoned. This

plate, like the bottom plate, is also halved at junctions. All framing needs careful bracing, which is highly important in all frame work. This may be done with cross lacings of stout galvanized hoop-iron, pulling one against the other, or by wood braces cut into studs and top and bottom plates, and set at raking angle across each section of the studding, as seen in the diagram.

A common ridge roof for galvanized iron covering is shown. This consists of ceiling joists spaced 18 in. apart centres for plastering, with rafters at 36 in. apart centres (which is sufficient for iron), and collar ties nailed to sides. The rafters are scribed to the ridge, from which is suspended a "hanger," which relieves the ceiling joists across the centre of wide apartments. Upon the side of this beam fillet pieces are nailed to receive joists. Such a beam often rests upon end walls, and is made deep enough to do the work without being suspended. Battens are nailed horizontally at intervals to receive the roof iron; these should be about 30 in. apart centres, but differ somewhat, being made to suit sizes of iron sheets. The fascia is nailed to the ends of projecting rafters, and the spouting mold laid on.

The studs in this case are covered on the outside with common feather-edged weatherboards, with 1¼ in. lap, nailed through the thick part of the outer boards, to pinch, not to nail, the thin part of the under boards, the boards being set to gauge, to show truly horizontal and fair from outside when finished. Weatherboards are also made with rounded edges, and with rebatings, &c. Those mostly used, such as the imported Baltic and common hardwood, are here shown. Hardwood weatherboards require more lap than the imported, as they shrink more. Angles are finished fair up against vertical stops, which are generally about 2½ in. by 1½ in. At openings, such as doors and windows, horizontal stops are also formed by the linings or frames. Where white ants are prevalent, the space under the floor is best left quite open; in other cases, especially where sloping ground is met with, the space below the vermin plate may be filled in with rough boarded "sheeting,"

which should be of timber not affected by ground damp. For ordinary level work, the bottom of the weatherboards may be finished down on to a stout plinth as shown.

Openings.—In wooden framing the door and wooden openings have to be arranged by trimming. This is usually done by increasing by one inch the thickness of the timbers around the three sides of the opening, and trimming in head and sill pieces. In this way door and window frames do not require to be as solid as where placed in brick or stone walls, as they receive from the rough woodwork some general support. For a large wood frame building refer to " woolsheds " (Plates XXIV. and XXV.)

Temporary Carpentry.—A certain percentage of carpenters' work may be classed as " temporary," as it is directed towards the making and maintaining of certain things, not necessarily a permanent part of the building itself, such as scaffolds, temporary ladders, hoists, casings, centres, hoardings, overways, shores, &c.

Scaffolds are of various kinds, the most common being made up of scaffold poles lashed together with cords, supporting short horizontal lengths of square timber, called put logs, which rest in the walling and support the scaffolding boards.

Scaffolds are sometimes carried out with light steel bracketing hung to walls as the work proceeds. In some cases the scaffolding is carried up entirely on the inside of the building; but whatever its character its stagings should be ample and secure.

The various trades also have their own scaffolding, suited to their work, which is known technically as " plant."

Hoists are of various kinds, from the common hand winch to the universal steam crane or traveller. The latter is found necessary in large stone jobs and has to be carried on stout baulk timbering at such height as to get above the lifting required.

Casings.—All stonework, such as plinth, sills, steps, as well as any specially finished work in cornices, wood sills, and especially sharp arrises, &c., requires to be cased up with rough wood casing to

protect them from injury as the work proceeds. These are gradually removed from top to bottom at completion of the work.

In concrete work casings have to be made to receive the concrete, which, in large jobs of reinforcing, may involve very considerable labour and ingenuity for the proper support of the masses in position.

Centres.—All arches other than the ordinary brick arches of flat rise, which are generally supported on iron bars, require temporary wood centres to support the voussoirs during building. These centres are made of rough boarding, cut to contour in duplicate, kept apart, and open battened on top, with fillet pieces upon which the stone or brick rests. These are propped up temporarily in position, in such a way that they may be struck when the arch is set.

Overways are to protect the footpaths and street channels from injury during the cartage of material. These are generally regulated by municipal and shire councils.

Hoardings are temporary screens mostly used in city buildings, and may extend over the footpaths, which have to be maintained for the use of the public. Such hoardings and enclosures have to be constructed and lighted as directed by the city building authorities.

Floors.—Wooden floors differ in character according to the work required of them. In domestic work a floor may be very lightly constructed, while in warehouses, where heavy weights have to be carried, together with wheel and working traffic, the floors require to be strongly constructed and heavily boarded.

Of yet another character are dancing flooors, which require to be both strong and elastic. Such floors, when upon ground levels, are best kept free from walls, and, as far as possible, independent, so that vibration may not be conveyed to the structure.

Ground Floors may be classed separately from "upper floors," as they have more under support. A ground floor is carried only partially upon the walls, as within the area of the apartment sleeper piers, sleeper walls, or stumps are set and bearers laid at

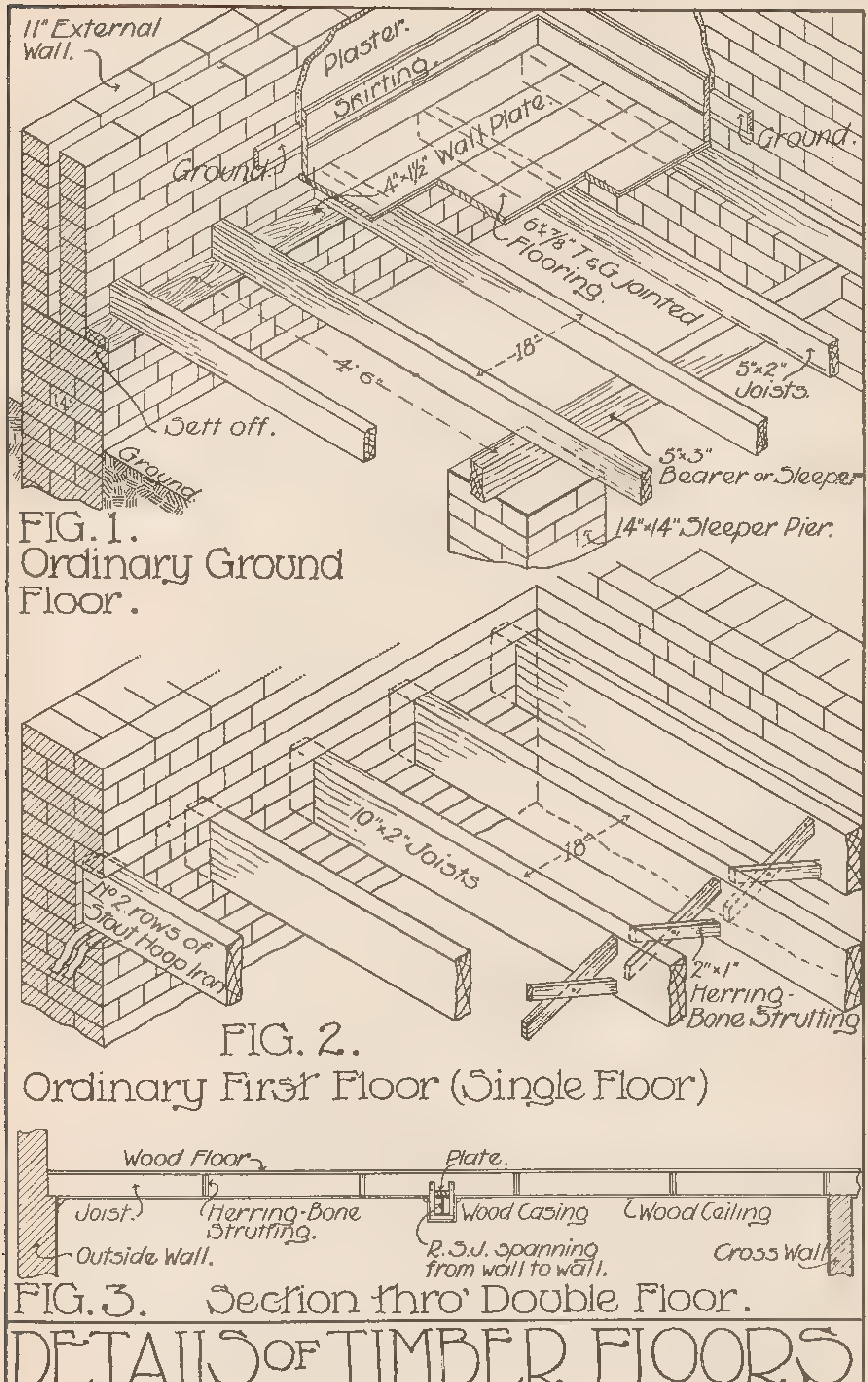


FIG. 1. Ordinary Ground Floor.

FIG. 2. Ordinary First Floor (Single Floor)

FIG. 3. Section thro' Double Floor.

DETAILS OF TIMBER FLOORS

right angles to receive the joists. (See Plate LXVIII., fig. 1, which shows an ordinary house floor.)

At the walls a set-off is built, upon which the wall plate, which is generally about 4½ in. by 1½ in. jarrah or red gum, is laid. Bearers span the apartment at distances of about 4 ft. 6 in. centres. These are best also of red gum or jarrah, or other timber not affected by damp. The joists may be 4 in. or 5 in. by 2 in., of hardwood, spaced 18 in. apart centres, and skew-nailed to plates and bearers. The boards or flooring are laid with tongued and grooved boards, laid, by preference, in the direction of the longest way of the apartment. These may be of various woods, thicknesses, and kinds, the most common being tongued and grooved kauri, red or white deal, jarrah, hardwood, &c., generally in sizes such as 6-in. by ⅞-in., 6-in. by 1⅛-in., 4-in. by ⅞-in., 4-in. by 1⅛-in., &c. Flooring boards should be laid in long lengths, with splayed heading joints, each board being closely cramped up with floor dogs, and bradded at each intersection of the joists. In ordinary flooring two oval wire nails are allowed to each board at the intersection of joists, the boards being laid groove-wise to the workman. The nails should be well punched in, and the floors cleaned off by planing at completion.

In floors for polishing or dancing the boards are secret nailed—*i.e.*, nailed to the joists near the tongues, the order of laying being reversed, by laying tongue-wise to the workman, the surface being afterwards traversed off—that is, planed dead level and true all ways.

Around fire-place hearths the boards are mitred to form margin.

Upper Floors.—Upper floors in ordinary work usually bridge from wall to wall. This is called "single flooring." Where the distance is too great for one span, the ordinary joists require to be supported by rolled steel joists or wood beams. Upper floors are constructed as shown in Plate LXVIII., fig. 2. Here the joists are shown deeper than for ground floors, and resting on a brick wall upon two rows of stout hoop-iron. At upper floor levels the wall

thickness is often reduced as the building rises. This creates a "set off," upon which the joists rest, and upon which a hoop or flat iron plate may be laid to receive the joist ends. The joists are here 10 in. by 2 in. and 18 in. apart.

Herring-Bone Strutting.—To stiffen the joints, and to keep them in upright position, herring-bone strutting is fitted and nailed in a row between joists across the apartment; this consists of 2-in. by 1-in. stuff diagonally cut, fitted, and nailed as shown. Hoop-iron is sometimes used for this purpose, laced over and under the joists diagonally.

Double Floors.—Where floor spans are excessive, the general way is to support the joists on rolled steel joists, into which the joists may fit and leave a fair soffit, or the rolled steel joists may be placed entirely underneath the joists, the joists resting thus upon the upper flange (see fig. 3). This is called "double flooring."

Floor Trimming.—Where openings are formed in floors, the timbers require to be increased 1 in. in thickness, and the openings trimmed as shown in Chapter X., Plate XLVIII., fig. 4.

Pugging.—Wooden floors are strong conductors of sound, and to obviate this upper floors are often "pugged." Pugging is coarse hair mortar laid upon rough boarding, set on fillets nailed to the sides of joists between the ceiling and the flooring. Though deadening the sound, pugging tends to endanger by decay the life of the timber, which is best left free from packing of any kind.

Fireproof Floors.—For fire-resisting floors, see Chapter XII.

WOOD PARTITIONS.—Timber partitions, either for plastering or for lining, are usually constructed in the same way as described for the walls of a wood frame building—*i.e.*, with top and bottom plate and upright braced studs and trimmed openings. Such partitions are usually carried upon the floors; if upon the upper floor of a brick building, and they require to be self-supporting, a rolled steel joist may be placed underneath to take the weight.

ROOFS.—*Generally.*—A very important part of carpentry practice

is directed towards "roof construction," which branch of building is now greatly supplemented by the introduction into modern work of reinforced concrete and steel construction.

While both concrete and steel, as constructive factors, are likely to be increasingly used for large and permanent commercial work, the great proportion of all-round domestic and general roof construction requires to be carried out in timber. The traditions, too, of old time carpentry—one of the noblest of all the crafts—are still too strongly influenced with the grandeur of the mediæval open roofs that grace many of the historic buildings of the old world to allow such admirable principles of construction to easily die ; for such examples must ever remain to show that a roof may be made more than simply utilitarian –it may be made both beautiful and useful.

Roofs are touched upon in "Roof Coverings," and reference should be made to that chapter and to the illustrations accompanying it, and especially to Plates LXXXVI., LXXXVII., and LXXXVIII., showing the various parts of an ordinary roof, so that from the outset some understanding may be arrived at as to the general terms used in roof work. Special attention is also directed to Plate LXIX., where some 17 types of roof principals are shown.

It should be clearly understood that it is only for wide spans that roof "principals" are required. The greater proportion of ordinary domestic roofing is carried out with "common rafter roofing" only. In designing a roof for any given building, consideration must be given first of all to the following points :—Quality and weight of roof covering, span between supports, angle of pitch, wind pressure.

Character and weight of ceiling (if any), &c.

Should the supporting walls not be at excessive distances apart, with a fair number of cross walls between, thus leaving open spans of not more than about 18 ft., as is the case in an ordinary house, a "common rafter roof" will be found sufficient, especially if the timbers be strengthened by strutting off the intervening walls, and the rafters well cross tied. On the other hand, in open spaced

buildings, the roof requires to be supported upon "roof principals." These consist of wood or iron trussed supports, spanning from wall to wall, at distances varying from about 8 to 12 ft. apart, so designed and set up as to support the common rafters, purlins, or battens required to hold the actual roof covering.

The former case would be illustrated by the house roof showing on Plate LXVII.

The latter case would be seen in the nave roof of an ordinary church building.

In roof construction the law of forces should be understood and allowed for in the strength, size, and position of the various parts, the object of roof bracing being to overcome the forces of compression and tension set up in the work, together with the force of torsion—*i.e.*, buckling or bending—that may take place under wind pressure or the weight of the roof covering.

To study these laws the student should make himself acquainted with the best books dealing with applied mechanics, with the test strengths of local materials, and with the average wind velocity readings of the district in which his building is to be erected.

Common Rafter Roofs.—Under the term "common rafter roofs" are included all sloping roofs that do not depend upon roof principals for their support. These are of various kinds, the simplest being the "lean-to" (Plate LXIX., fig. 1), which consists of single rafters set to slope, supported at each end by walls. Among ridge roofs the rafters may have joists as in fig. 2, or collar beam and joists as in fig. 3, or if over wide spans may have both collars and struts (fig. 4).

A simple, common rafter ridge roof, for corrugated iron covering and wood or plaster ceiling, is illustrated in Plate LXVII., and described with wood frame buildings.

For all ordinary domestic buildings this is the type of roof usually adopted. For tiles, slates, or shingle covering the rafters require to be about 18 in. apart centres, as also the ceiling

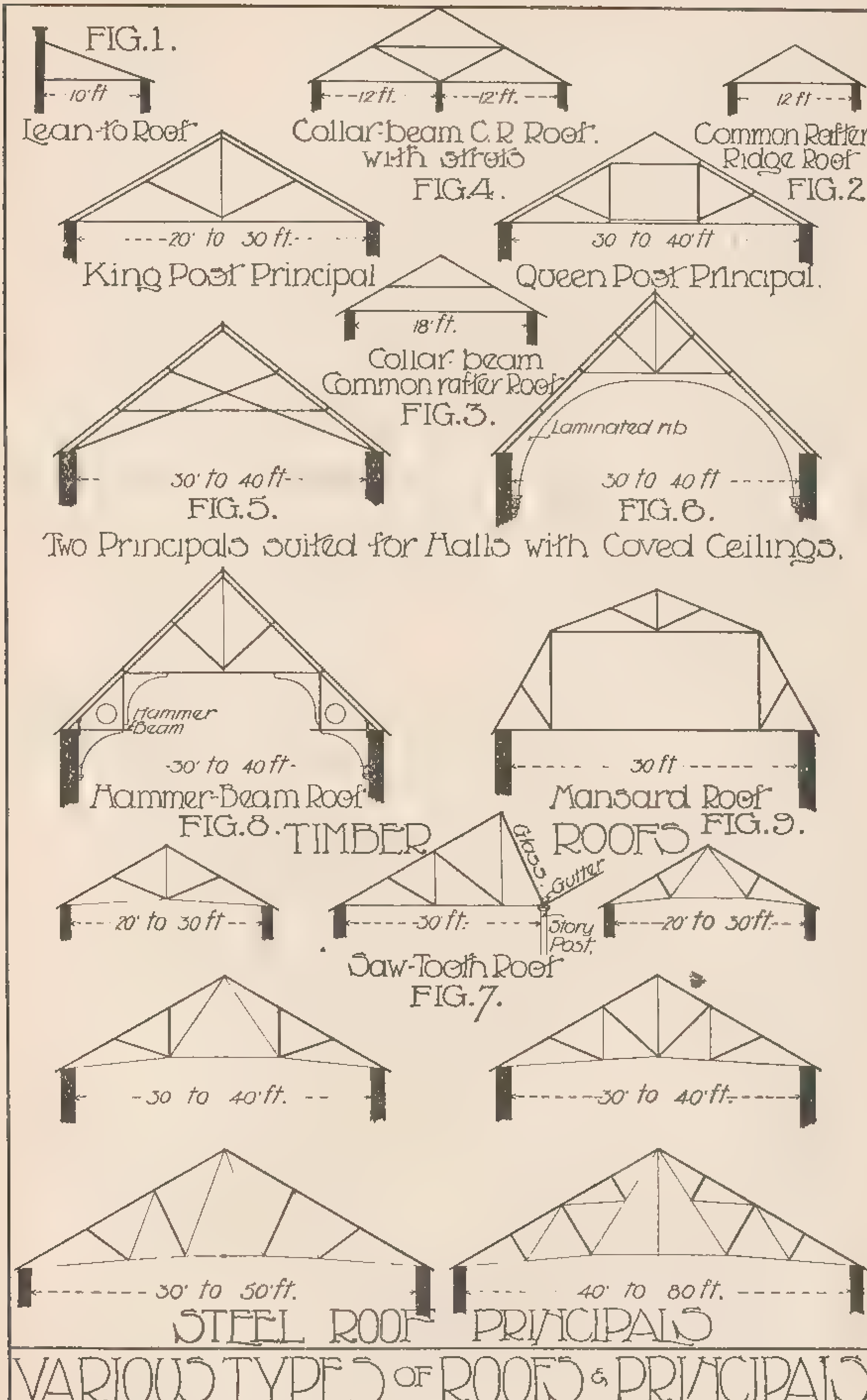


FIG. 1.
10 ft
Lean-to Roof
12 ft. 12 ft.
Collar-beam C. R. Roof. with struts
FIG. 4.
12 ft
Common Rafter Ridge Roof
FIG. 2.
20' to 30 ft.
King Post Principal
30 to 40 ft
Queen Post Principal.
18 ft.
Collar beam Common rafter Roof
FIG. 3.
Laminated rib
30' to 40 ft
FIG. 5.
30 to 40 ft
FIG. 6.
Two Principals suited for Halls with Coved Ceilings.
Hammer Beam
30' to 40 ft
Hammer-Beam Roof
FIG. 8.
TIMBER ROOFS
30 ft
Mansard Roof
FIG. 9.
20' to 30 ft
Glass
Gutter
30 ft.
Story Post.
20' to 30 ft.
Saw-Tooth Roof
FIG. 7.
30 to 40' ft.
30' to 40' ft.
30' to 50' ft.
40' to 80 ft.
STEEL ROOF PRINCIPALS
VARIOUS TYPES OF ROOFS & PRINCIPALS

joists for plaster. Where corrugated iron covering is used, rafters may be placed 36 in. apart centres and horizontal battens laid to receive iron.

Ridges, hips, and valleys are formed with deep timbers at the junctional meeting of the rafters, to which they are cut and nailed. Eaves are formed by the ends of rafters, and may be finished in several different ways. (See diagram in "Roof Coverings," Chapter XVI.)

Principal Roofs.—A principal roof is any kind of sloping roof supported by trusses or "principals." Such roofs above the principal are similar in all general particulars to common rafter roofs.

In principal roofs the truss is designed to carry the "purlins," which run at right angles upon the top of the truss; these in their turn take the common rafters, or if the roof be corrugated iron covered, the purlins alone may suffice, being placed closer together for this purpose.

There are a large number of roof principals, some of the chief types of which are diagrammatically illustrated on Plate LXIX.

Where roofs are hipped half-trusses are used.

King Post Roof.—A king post roof is shown in Plate LXX. This form of roof is suitable for spans of from 20 to 30 ft., and is illustrated very fully in detail on the plate.

The name of this principal, or "truss," as it is commonly called, is taken from the vertical centre or king post, which is designed to hold up the centre of the tie-beam, the attachment being by means of a stirrup iron pierced through near the top, and fitted with an arrangement of metal twin wedges called "cotters," having top and bottom pieces of iron called "gibs" for the wedge to work against in tightening up the work.

In this principal all the timbers are checked and tenoned, and at vital points strapped and bolted together with wrought iron.

On one side is shown a parapet wall with a box gutter, and on

the other side an ordinary eaves finish, all the special parts of which are shown by enlarged details upon the same plate.

Queen Post Roof.—A queen post roof principal is illustrated in detail on Plate LXXI. This principal is suitable for wide spans, the one shown being for a 40-ft. span with trusses 10 ft. apart.

Here, unlike the king post, two posts are arranged, called "queen posts." The figure shows the arrangement of the various parts, and the scantlings required for ordinary slate roof covering; some enlarged details being given of the junction of the queen post head, purlins, and rafters, also the tie-beam attachments. This figure shows the fixing of ordinary ceiling joists and plastering to the tie-beam, for the purpose of forming a ceiling.

Roofs for Coved Ceilings.—Where it is necessary to raise the general ceiling level of an apartment above the walls, this may be done, in a common rafter roof, by the omission of the ceiling joists, and the insertion of collar beams at the height required, the exposed slope of rafters and collars being then lined to form the ceiling.

When a similar arrangement is required in a large building, such as an assembly hall, the roof principals have to be designed so as to make possible this type of finish. Plate LXIX., figs. 5 and 6, show two ways of carrying out such a problem. Fig. 5 shows a moderately pitched roof, having the rafters diagonally braced across, and with a low-set collar beam, which together form a coved ceiling.

Another type of principal for a half-open roof is shown in the next figure (fig. 6). Here the general roof pitch is higher, and the ceiling more expansive. The rafters and collar are connected to each other and to the wall with laminated rib timbering—*i.e.*, timber in several thicknesses, fitted to circular sweeps, which follow the line of the principal and come down the walls to rest upon ornamental corbels.

Such a ceiling may be lined in various ways by exposing the purlins, or by the introduction of joists, so arranged as to carry

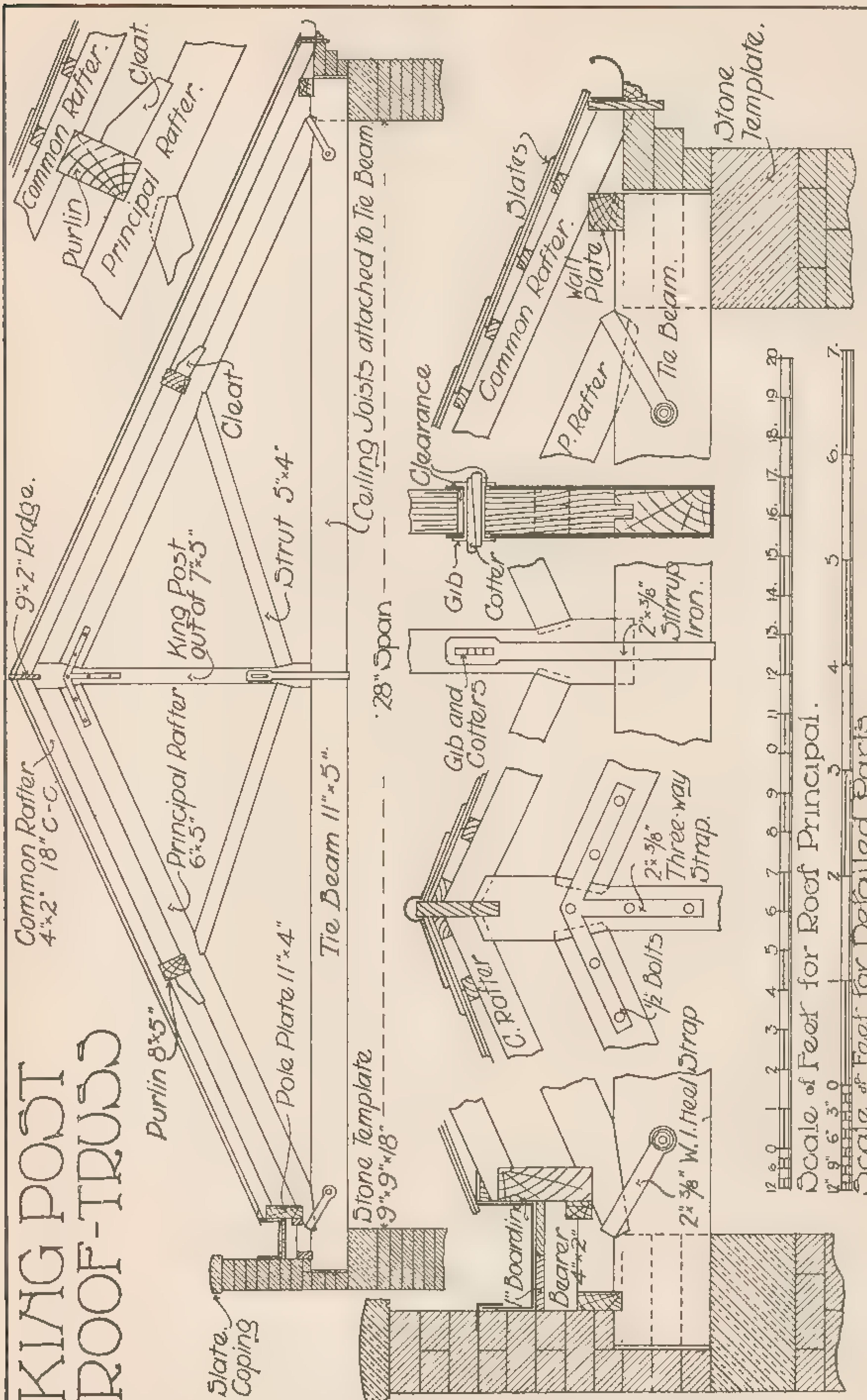
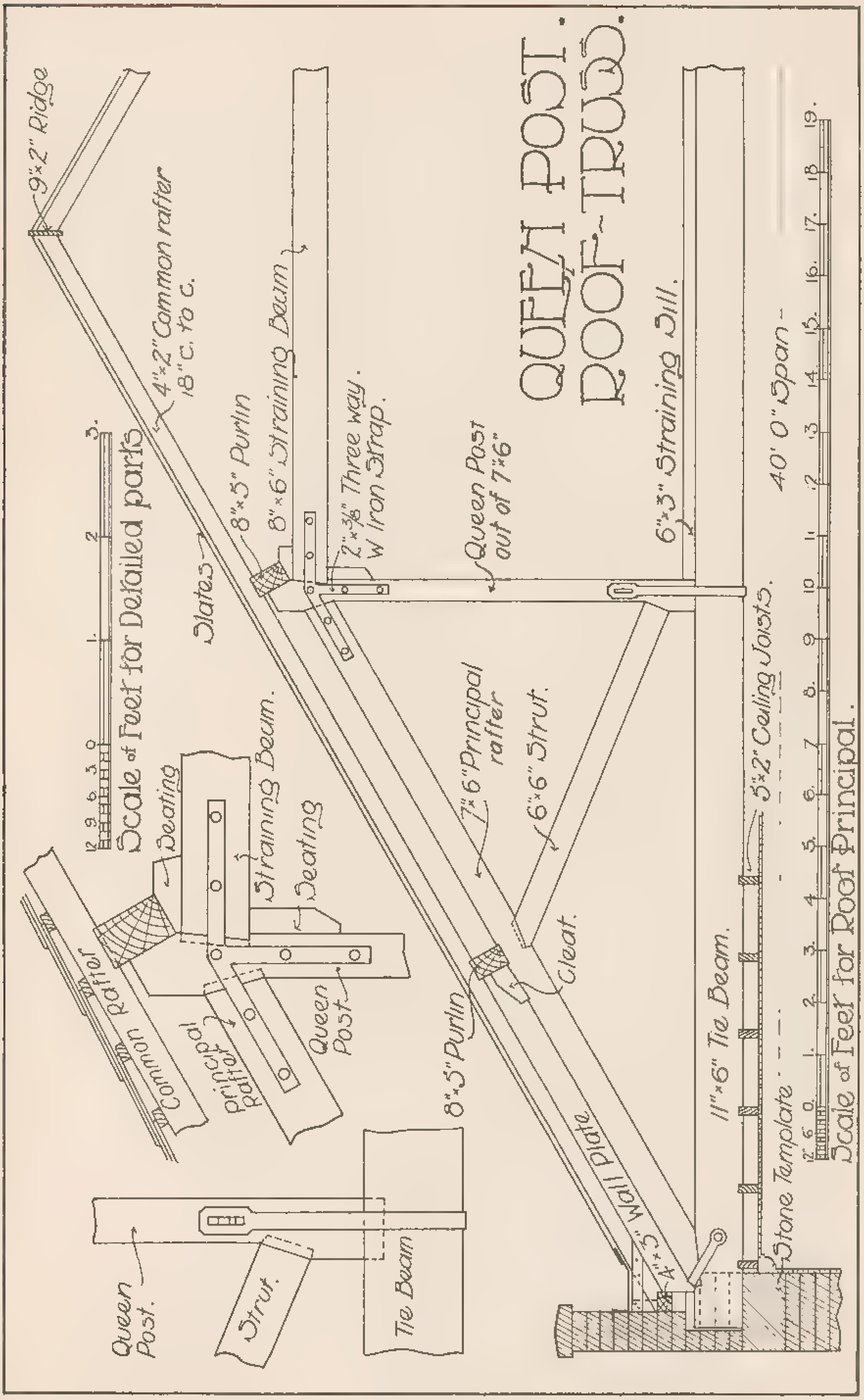

KING POST ROOF-TRUSS
Common Rafter 4"×2" 18" C-C.
9"×2" Ridge.
Principal Rafter 6"×5"
King Post out of 7"×5"
Strut 5"×4"
Cleat
Purlin 8"×5"
Pole Plate 11"×4"
Tie Beam 11"×5"
Ceiling Joists attached to Tie Beam
'28" Span
Stone Template 9"×9"×18"
Slate Coping
Common Rafter.
Cleat.
Purlin
Principal Rafter.
Slates
Common Rafter.
Wall Plate
Tie Beam.
P. Rafter
Stone Template.
Clearance
Gib
Cotter
Gib and Cotters
2"×3/8" Stirrup Iron.
C. Rafter
2"×3/8" Three-way Strap.
1/2" Bolts
Strap
2"×3/8" W.I. Heel Strap
1" Boarding
Bearer 4"×2"
Scale of Feet for Roof Principal.
Scale of Feet for Detailed Parts.

PLATE LXXI.



QUEEN POST. ROOF-TRUSS.
9"×2" Ridge
4"×2" Common rafter 18" C. to C.
8"×6" Straining Beam
8"×5" Purlin
Slates
2"×3/8" Three way. W Iron Strap.
Queen Post out of 7"×6"
6"×3" Straining Sill.
40' 0" Span
7"×6" Principal rafter
6"×6" Strut.
Cleat.
8"×5" Purlin
Wall Plate
4"×5"
11"×6" Tie Beam.
5"×2" Ceiling Joists.
Stone Template
Scale of Feet for Roof Principal.
Scale of Feet for Detailed parts
Seating
Straining Beam.
Seating
Common Rafter
Principal Rafter
Queen Post
Queen Post.
Strut.
Tie Beam

close boarding, the lamination of the truss and portion of the collar only remaining visible beneath the lining. This makes a suitable roof for church work, but in wide spans the principals require a cross tie-rod to relieve the tendency of the feet of the principal rafters to kick out over the walls.

Roofs with coved wooden ceilings are, in practice, usually found to give very satisfactory acoustic results for assembly halls and similar open buildings, and are designed in a great number of differing ways. Care, however, should always be taken to tie in, as well as possible, the legs of the principals. A detail of laminating is shown in Plate LXVI., fig. 10.

Saw-tooth Roofs.—Mellow, shadowless roof lighting over extensive floor areas is often specially required over such buildings as wool-rooms, factories, store sheds, &c., and this requirement is met by the "saw-tooth" form of roofing (Plate LXIX., fig. 7). This type of roof is arranged to carry a vertical or slightly sloping light upon one of its sides, generally facing south; the whole of the construction being directed to secure a well-diffused neutral and properly reflected light. These roofs are usually covered with galvanized corrugated iron, with principals framed up at intervals and carried on wooden story posts or steel or cast-iron uprights. The purlins to take the iron are run in long lengths from end to end of building upon the top of the trusses, and the iron secured directly to the purlins. The lights may be continuous or intervening between closed-in spaces.

Hammer Beam Roofs.—The hammer beam roof (Plate LXIX., fig. 8) is a form of roof that has become a standard for important Gothic work. One of the most beautiful examples of this type of roof is to be found in old St. Stephen's Hall, Westminster (London), which should be referred to for characteristic detail. The distinctive feature of this type of principal is the introduction of the "hammer beam," a cantilever-like form projecting inwards from the face of the walls, taking the place of the usual tie-beams.

Open Timber Roofs.—Much dignity and beauty is created in

college halls, churches, and ecclesiastical buildings by the adaptation of some form of the open timber roof. In these roofs the structural timbers are wrought and allowed to show from below, revealing the general construction and framing, consequent upon which ornamental moldings, carving, and ironwork are often introduced to relieve the plainness of the structural timbers.

Mansards.—The Mansard roof (Plate LXIX., fig. 9) is a distinctive type of high roof which originated in France and has much vogue for a certain style of Renaissance building. Its towering mass gives a certain dignity to a high building, and affords space in the roof for rooms.

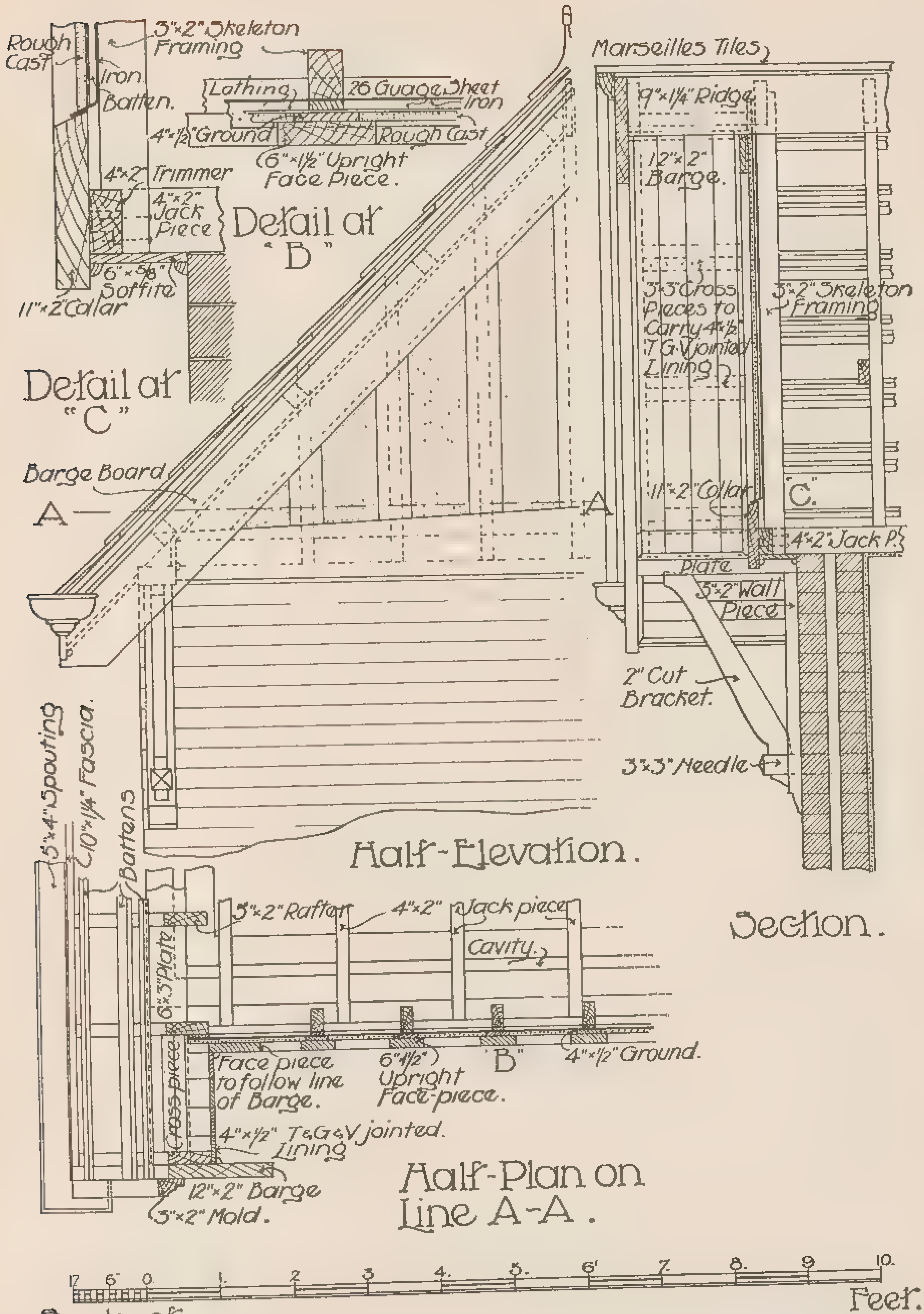
Combined Wood and Iron Roofs.—For notes on iron roofs reference should be made to Chapter XIV.—Steel and Iron in Construction. In roofs where the principals themselves are of steel a certain amount of carpenters' work is sometimes introduced, such as in "purlins," common rafters, gutters, fascias, &c.; and in other ways steel may be introduced in conjunction with timber, where the principal rafters of a truss are wood and the tying and bracing is of steel.

Metal tie-rods are of common application in wooden principals, as also "king bolts" in place of king posts. In some principals improved connections are made by introducing cast-iron shoe pieces to end of principal rafters resting upon the walls, or when king bolts are used a cast-iron king head may be adopted to take the ends of the principal rafters and the top of the hanging king bolt. In any case a certain amount of smiths' work is always to be found in heavy roof construction, where strappings and boltings form a very important part of the constructive carpentry.

In metal work provision should be made, as far as possible, for tightening up the work, so that when the timber shrinks the various parts may be overhauled and brought to their proper bearings.

Trimming.—In constructing a roof the various timbers require to be "trimmed" around all openings such as chimneys, trap doors,

PLATE LXXII.



Scale of 12 6 0 1 2 3 4 5 6 7 8 9 10 Feet.

DETAILS of HALF-TIMBER^D GABLE

skylights, &c. This is done in a similar way to "Floors." See page 332.

Roof Lights.—Where apartments are lighted from the roof space, provision is made for trimming around the openings, and also for carrying the added weight of the light, which, in addition to heavy weight of glass, requires to be stoutly constructed and well flashed.

The "skylight" (Plate LXXXV., Chapter XVI.) is one of the simplest forms of roof lights. This consists of an upstanding frame holding a sash filled with glass, which may be either hung or fixed.

A "dormer" is another form of light, and is also shown in Plate LXXXV. Dormers may be at the eaves or higher up the roof slopes, and are of a great variation of design. Usually they are framed in timber and have sashes in solid frames.

A "lantern" is a form of roof light used for lighting the internal parts of a building from the roof, and is much adopted in large business premises, shops, &c.

A lantern usually consists of a framework wholly or partially filled with glass, upstanding above the general roof slope. Lanterns may be square, rectangular, or domical.

Gables and Half-timbering.—In domestic buildings where gables are used it is usual to carry the gabling out beyond the external face of the walling, and to finish with "barge boards" or "half-timbering" of some kind.

Such a gable is shown in the perspective sketch (Plate LXXXV., Chapter XVI.), and fully illustrated in detail on Plate LXXII.

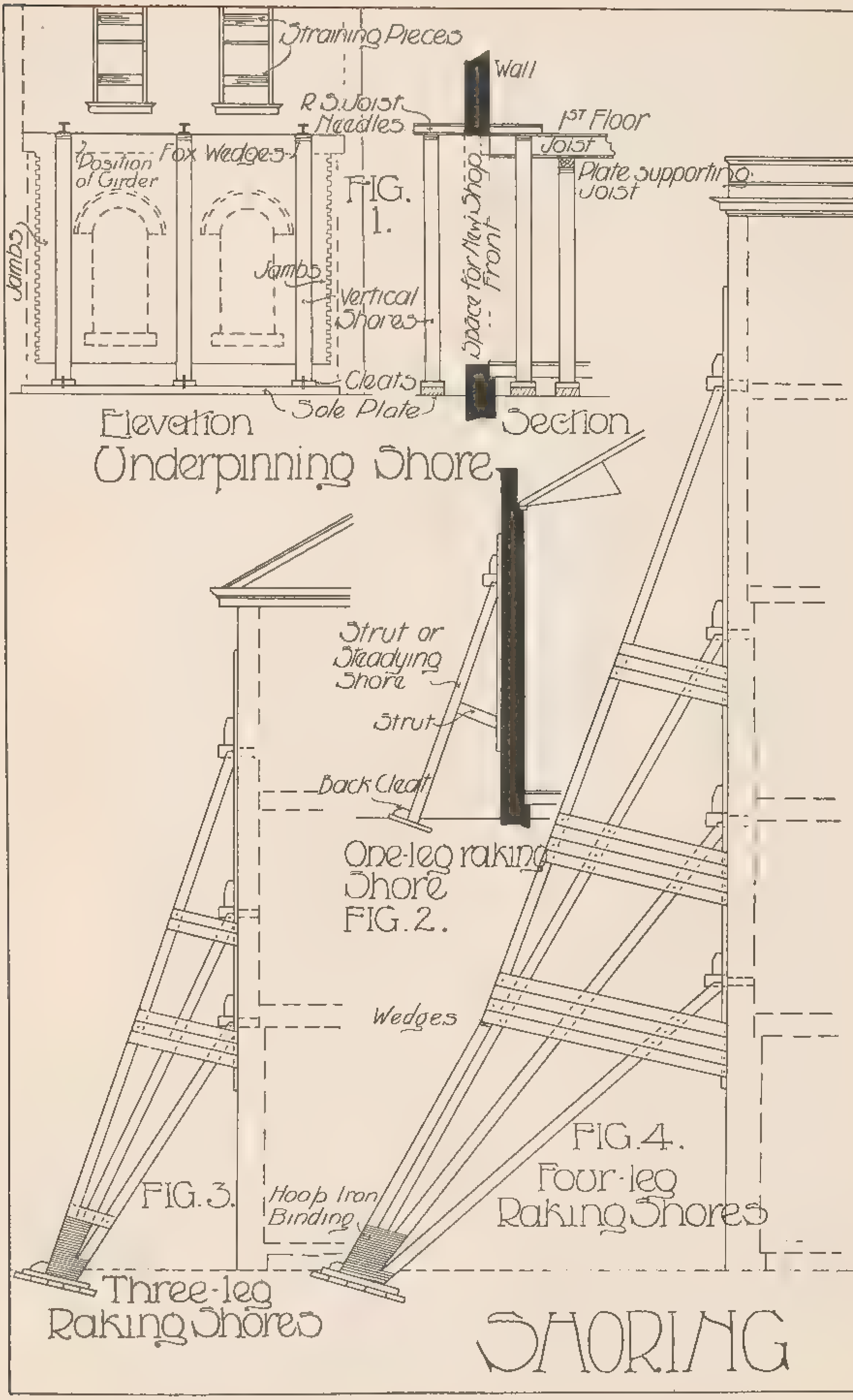
Half-timbering is a very ancient form of old English building some of the best examples dating back to Elizabethan days, and showing fine constructive form and picturesque detail. The old work was usually built with solid skeleton-framed timberings through the full thickness of the walls, infilled between with brickwork or plastering. In modern practice where half-timbering is used fair face woodwork is generally made to stand upon the outside face of rough framing. This is the case in the diagram (Plate LXXII.), where the gable is filled in with half-timbering. In this class of

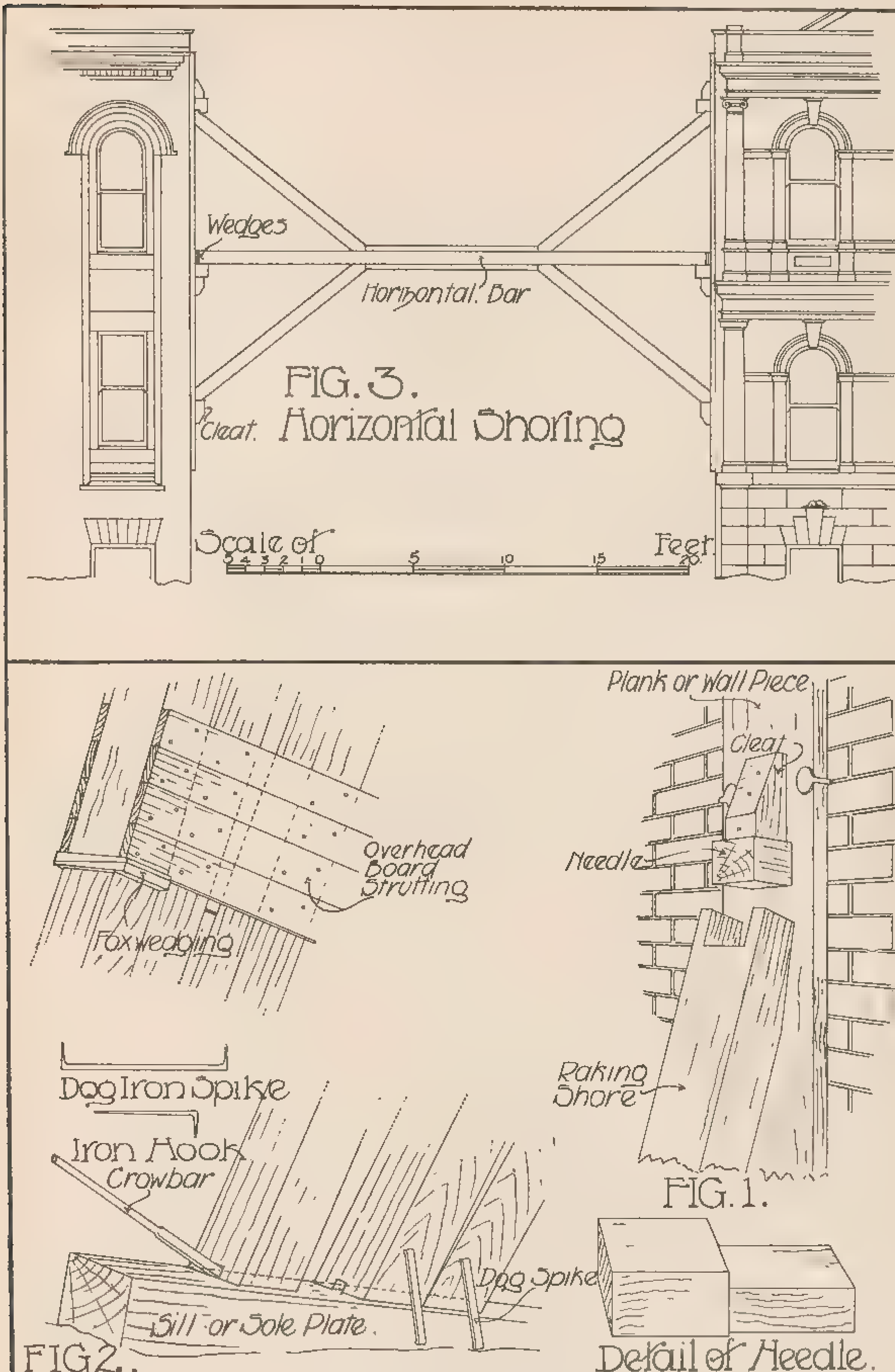
work great care requires to be taken to prevent the indriving of rain, one way of preventing which is shown in the detail. In a gable of this kind all the available timbers should be extended to support the barge board, such as the ridge and wall plates; short supplementary pieces, called "jack pieces," are also carried out to take the weight of the projecting half-timbering.

This half-timbering consists of a skeleton frame of rough timber, corresponding to and at back of the visible half-timbering. This framing (see detail at "B") is first lined over with galvanized sheet iron. A batten is then interposed, and the whole lathed over. A ground is then fixed in front to receive the final covering pieces, the plastering being laid between. In this way the water is prevented from entering, and a key is secured at back of the covering pieces for the plaster. There are other ways of carrying out this class of work, but this has the approval of tried practice. Barge boards are the boards that finish the roof ends, such as to lean-to ends or gable ends. The one shown on the plate is 12 in. by 2 in., and has a mold on top, upon which the final row of tiles rests. The projecting wall plate is strengthened to carry the barge by stout brackets, one on either side. In large gables in front of purlin roofs the purlins are sometimes carried out to receive the barge. Barges may also be cut to shape, molded, and finished with finial posts or in other ways. Great variety may also be given to the finish of the half-timbering.

Shoring and Underpinning.—In dealing with old buildings where structural alterations or repairs have to be carried out, shoring is often found necessary.

Shoring is a term applied to the temporary supports used for carrying or steadying walls, or other structural parts of a building, and now follows along certain more or less definite principles of common practice, for which reference should be made to Plates LXXIII. and LXXIV. Here are seen the types of common shores which may be classed as "underpinning shores,"


Straining Pieces
Wall
R.S. Joist
Needles
1st Floor
Joist
Plate supporting Joist
Fox Wedges
Position of Girder
FIG. 1.
Jambs
Jambs
Vertical Shores
Space for New Shop Front
Cleats
Sole Plate
Elevation
Section
Underpinning Shore
Strut or Steadying Shore
Strut
Back Cleat
One-leg raking Shore
FIG. 2.
Wedges
FIG. 4.
Four-leg Raking Shores
FIG. 3.
Hoop Iron Binding
Three-leg Raking Shores
SHORING


Wedges
Horizontal Bar
FIG. 3.
Cleat.
Horizontal Shoring
Scale of Feet
5 4 3 2 1 0 5 10 15 20
Plank or Wall Piece
Cleat
Needle
Overhead Board Strutting
Foxwedging
Raking Shore
FIG. 1.
Dog Iron Spike
Iron Hook
Crowbar
Dog Spike
Sill or Sole Plate.
FIG 2.
Detail of Needle.

SHORING

"raking shores," and "horizontal shores." These differ widely in length, scantling, and character, according to their position and the work required of them. Shores, too, are also greatly influenced by the contained space in which the shore must work—a very great consideration where clear space is limited, or where the shore has to be erected upon a street frontage or limited adjoining property.

Oregon timber is most suitable for shoring, with ground sills of some dense, hard timber capable of withstanding crushing.

Dry hardwood is generally considered best for wedges, very slightly tapered, so as not to jump back when driven.

Underpinning Shores.—Plate LXXIII., fig. 1, illustrates a common example of underpinning shoring where an old dwelling-house is being converted into a shop.

The first work, in such a job, is to temporarily shore up around the upper window openings and to put in straining pieces so as to make as much as possible one mass of the superstructure. When this has been done, needles are inserted through the strongest part of the wall in the centre of the piers. These needles are best of rolled steel joisting, as steel requires a smaller hole than wood. The needles stand over both in front and back of the wall (see section), and are supported at either end by stout vertical shores, resting upon continuous sole plates secured with cleat pieces to prevent kicking. Fox wedges—*i.e.*, wedges in duplicate are inserted at the top ends of the shores, and driven home to tighten up under the needles and take the weight.

The support of the upper flooring depends upon the direction of overhead joists, also whether there is a basement or not, as all shores must be taken down, in every case, to solid, firm bearing. In this case the shore is taken through the ground floor to the ground. These shores have, along the top, a continuous plate to receive the joists, lying at right angles to the front wall.

After firmly shoring up and supporting the work, in the way illustrated, the underneath walling may be removed, the jambs built up fair with brick or stone in cement mortar, and a girder, of

sufficient strength to take the overhead weights, hoisted and set in position, and all made good around to the old work. The shores may then be carefully removed by driving back the fox wedges and gradually allowing the new work to take its bearings.

The aforesaid illustrates the general principal of underpinning which is applied in a large number of different ways, especially where basements are created to old buildings, or where a new building with a basement comes against an old building without a basement. In such a case the old wall has to be underpinned. This is done by excavating the ground in small sections, and building up solid walling under the old wall. This is repeated alternately right along the wall, when a return is made to deal with the interleft spaces, which are treated in the same way till the whole wall is underpinned with new walling. While this class of work is being carried out it is customary, should the wall be an outer wall, to steady it with a "raking shore" (see Plate LXXIII.)

Raking Shores are used for bulging walls or for walls that require steadying during underpinning. They vary with the height of the building, the number of the floors to be supported, and the position of the exact spots of weakness requiring strengthening.

Plate LXXIII. shows three kinds of raking shores—the one, three, and four-legged shores—the enlarged details of which, with technical terms of parts, are shown on the lower portion (Plate LXXIV.)

Plate LXXIII., fig. 2, illustrates the one-legged raking shore, giving general support to a leaning wall of a one-story building. This shore consists of a wide wall plank placed firmly against the wall and secured with wall hooks. Through this plank a needle is mortised (Plate LXXIV., fig. 1), and pierced putlog-wise into the wall. This needle is rebated; and the head of the leg is notched out to receive it, a cleat being placed above the needle for the purpose of stiffening the union.

The leg of the shore is cut top and bottom, to rake at the required angle, the foot resting upon a sill or sole plate (Plate

LXXIV., fig. 2), which is levered tightly into position with a crowbar and side dog spiked and back-cleated in position.

Raking shores are placed at such distances along the length of a wall as the nature of the work requires.

Plate LXXIII., fig. 3, shows a three-legged raking shore with needles inserted at unequal heights apart, and the foot of the shore correspondingly further away from the foot of the wall than the one-legged shore (fig. 2). The feet of the three shores, which are closely bound together with hoop iron, here meet together, and rest upon a laminated sill—*i.e.*, a two thickness sole plate. Overhead board strutting is secured to both sides of the legs to stiffen up the whole construction.

The four-legged raking shore (fig. 4) is constructed in the same general way as the three-legged shore, save that the top outside leg has to be arranged in two lengths at varying angles, the connection being used as a point from which to tighten up by fox wedging. This shore gives support to a five-story building, and requires considerable spread and space for its effective use.

Horizontal Shores.—Where two buildings come side by side over a limited intervening open space, as in Plate LXXIV., fig. 3, a bulging outside wall may be steadied by a horizontal or flying shore. This type of shore is not dependable upon the ground at all, but consists of a long horizontal beam straining across the opening and resting upon central needles. This beam is fox wedged at the ends and has top struts giving support to the highest needles, a pair of lower struts stiffening the whole and assisting in the support of the horizontal beam.

N.B.—Shoring and underpinning is work that may only be undertaken with safety by experienced workmen, acting under skilled supervision, as both the safety of life and public convenience is often involved in this class of work, the stresses and strains of which have to be most carefully calculated and counteracting support applied.

Old stone rubble walls are among the most difficult to underpin,

owing to the looseness of their adhesive quality. For this reason, good brickwork in cement mortar is best. The adhesive strength of good walling is often very great, and may be made use of in such positions as under windows when walls are being underpinned, where the walling may often be strong enough to carry itself between the needles. When adhesion does not exist or is weak, lengthwise support must be given or the work taken down as required between the needlings.

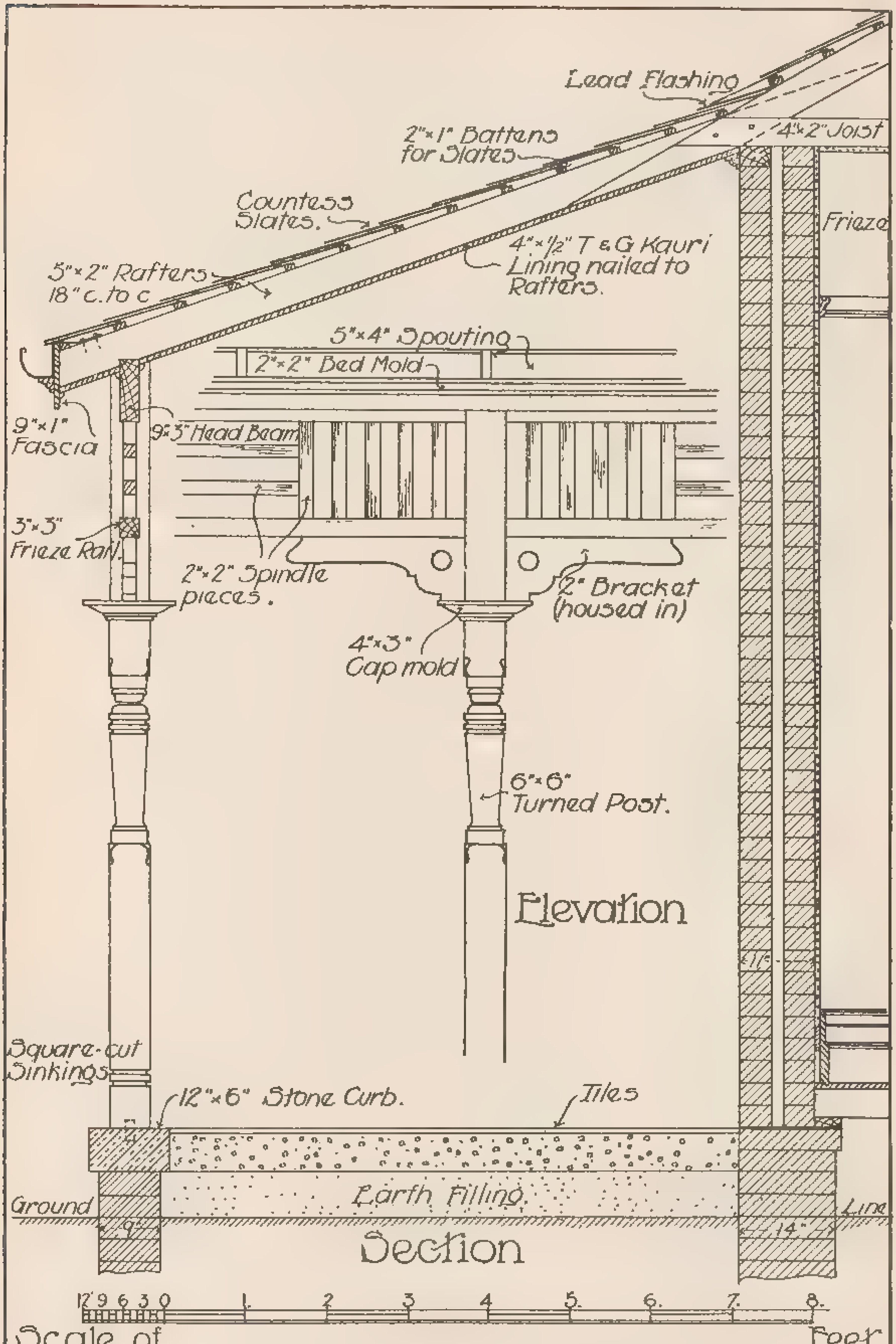
Shores in public streets are always under the supervision of public authorities, and have to conform to widths of footpaths and other conditions. They require also to be properly lighted and maintained.

Verandahs and Balconies.—The verandah, as a highly useful and constuctive feature, must always be of the very greatest importance in Australian architecture. This useful adjunct of our domestic, as well as of our semi-public buildings, gives rise to great diversity of treatment and consequent variation in the mode of construction.

In street verandahs over public footpaths the construction is generally regulated by public authorities. It is therefore with the altogether private verandah we have here to do, such a type, for instance, as that illustrated in Plate LXXV.

This figure shows an 8 ft. wide wood verandah with tile-laid floor set on concrete and laid to a 2-in. fall to outer edge, having a stone curb resting upon shallow brick walling. The posts, which in this case should be about 8 ft. apart, are turned in a lathe to pattern with square-cut sinkings near the base, and projecting cap molds mitred around the top. Each post is dowelled with galvanized iron into stone curb, and at the top is forked over a 9-in. by 3-in. continuous head beam, to which it is bolted.

The head beam receives the rafters, which rest at the top on the outside wall plate, and being nailed to the sides of the general



DETAIL OF WOOD VERANDAH

roof rafters, form an integral part of the main roof, but at a slightly flatter angle.

In this verandah a frieze rail is shown housed at ends into posts and receiving the square spindle pieces. Brackets are placed at angles of post and rail, to both of which they are housed. The eaves are here shown as simple cased-in eaves, and the under side of rafters is lined with 4-in. by ½-in. T. and G. and V-jointed lining boards, secured horizontally.

This figure shows only the ordinary principle of domestic verandah construction, the details of which may be very greatly varied. Posts are sometimes left square. The frieze rail and spindles may be dispensed with altogether, the eaves may show open rafter ends, the posts may be grouped in pairs or triplets, and in many other ways the design may be varied without destroying the basic principle of construction here illustrated.

Where balconies are superimposed over verandahs, the posts may be made continuous for the full height of both verandah and balcony. Turning, however, must not be specified, as a lathe would not be long enough to take the work; effect in this case could be obtained by square sinkings. If desired, the posts may be in two heights, stoutly secured to an interposing plate.

A balcony floor may be formed by stout bearers, resting in the wall at one end and upon the head beam at the other, receiving joists same as to ordinary flooring, the flooring boards being laid to fall and at right angles to the walls, with rounded and projecting ends into eaves spouting. Such flooring should be in extra narrow widths of timber, capable of withstanding outside weather, and should have all the joints run in thick white lead. This description applies equally to a wooden verandah floor, save that, in such a case, the joists need only to be of shallow depth, as they may receive half-way support from stumps placed midway across the verandah, the posts of the verandah in such a case being carried on stumps, with a stout front bearer on top running the length of the verandah, over which the posts may be halved or forked and bolted.

The roof of a balcony may be formed exactly as shown on verandah roof (Plate LXXV.) Handrailing, generally of molded wood, is housed into posts, and balustrading either of wood or iron infilled. If wood be used, the work is best specially kept up from actual floor, as tenoning into the floor leads often to soakage and decay. In wood balustrading, therefore, a better plan is to form a bottom rail a few inches above the floor, into which balusters may be housed.

A type of balcony and verandah that finds some favor in certain districts is constructed by projecting the usual first floor joists right through the outer wall, and allowing them to stand over cantilever wise for a few feet, upon which a shallow balcony is built in the usual way. A wider verandah is formed underneath, and the short space between the projections of the balcony and the verandah is roofed over. This makes a variation of projection along the front of the building.

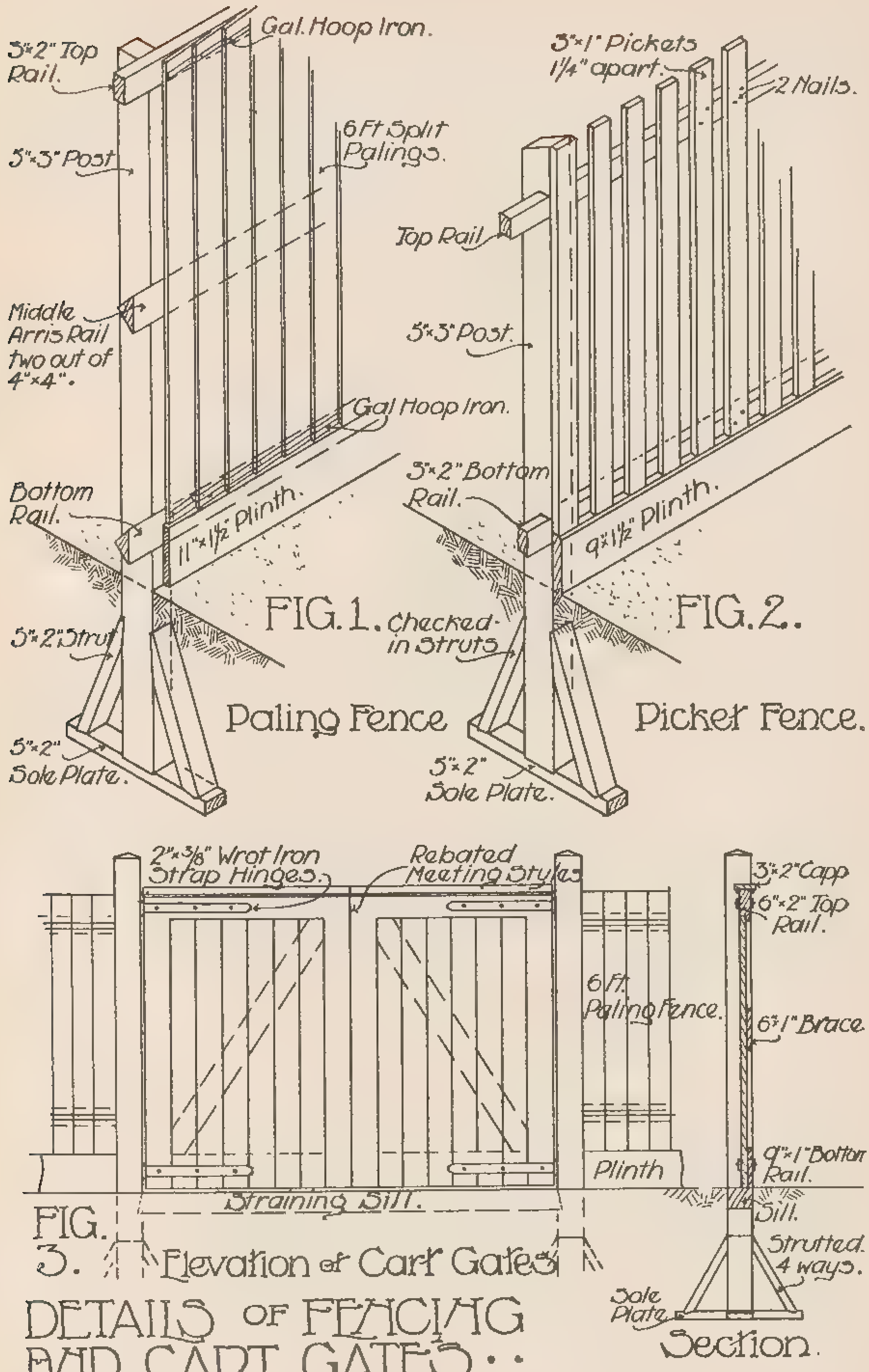
Ironwork is often substituted in part for woodwork in verandah and balcony construction, ornamental cast-iron posts, frieze ornaments, brackets, handrails, &c., being cast and made for the purpose. These all have lug attachments, and are screwed or bolted in position Where the roof is covered with iron in place of wood, tee and angle steel and flats are mostly employed, a very light lattice girder being carried along the front from post to post, to give eave support.

For other references to verandahs see "Shops," Chapter VI.

Fencing and Gates.—Fence enclosures around buildings are generally "wire," "close," or "picket."

Wire Fencing, of which there are several admirable systems, is now increasingly used. These consist of posts or steel uprights set at distances of about 9 ft. apart, having a number of wires horizontally strained through, with metal stiffeners interlaced vertically between the posts, the horizontal wires being closer together as they approach the ground, so as to keep out dogs.

PLATE LXXVI.


3"×2" Top Rail.
Gal. Hoop Iron.
5"×5" Post
6 Ft Split Palings.
Middle Arris Rail two out of 4"×4".
Gal Hoop Iron.
Bottom Rail.
11"×1½" Plinth.
FIG. 1.
5"×2" Strut
5"×2" Sole Plate.
Paling Fence
3"×1" Pickets 1¼" apart.
2 Nails.
Top Rail
5"×5" Post.
3"×2" Bottom Rail.
9"×1½" Plinth.
Checked in Struts
FIG. 2.
Picket Fence.
5"×2" Sole Plate.
2"×⅜" Wrot Iron Strap Hinges.
Rebated Meeting Styles
6 Ft. Paling Fence.
Plinth
Straining Sill.
FIG. 3.
Elevation of Cart Gates
3"×2" Capp
6"×2" Top Rail.
6"×1" Brace.
9"×1" Bottom Rail.
Sill.
Strutted 4 ways.
Sole Plate
Section.
DETAILS OF FENCING AND CART GATES

This type of fence, while maintaining a boundary, gives free air and openness.

Close Fencing is generally covered with split gum palings, galvanized corrugated iron, or lapped vertical boarding, the general principle of skeleton framing being the same for each.

Such framing consists of posts (Plate LXXVI., fig. 1)—for example, 5 in. by 3 in., with checked-in struts and sole plate sunk in the ground to depths according to the nature of the soil (generally about 30 inches), firmly rammed and kept vertical. These posts are sunk at distances of about 8 ft. 9 in. apart, so as to allow of the use of 18 ft. horizontal rails. Three rails should be used in a fence of 6 ft. in height or over; there are "arris" rails, two out of 4 in. by 4 in., or rails of ordinary scantling—say, 3 in. by 2 in. The rails are checked in flush with one side of the post, the end joints of the lengths being placed to break joints. A plinth is laid next the ground, nailed to the sides of posts, and, to prevent twisting, is best also attached to the bottom rail. The framework is now ready for the covering.

Fencing posts and plinth should always be of timber such as red gum or jarrah, which will withstand ground damp. The rails are usually of hardwood.

Such a fence may be covered with 5 or 6-ft. split palings, which are slightly feather-edged, set vertically to lap 1½ in., and nailed with one long thin round wire nail to each rail, so as to pinch (not nail through) the next paling. This prevents the splitting of the palings when shrinking.

Palings are strengthened by rows of galvanized hoop iron, bent to fit into the shape of the palings, and nailed with thin galvanized clout-headed nails. Where iron is used for covering, it is generally of 24-gauge corrugated iron, set vertically on top of a wood plinth, with a two-corrugation side lap, nailed through each third corrugation with galvanized spring-head nails, or secured with galvanized screws and washers to the rails. In corrugated iron fencing, the iron may be kept up somewhat above the line of the

top rail, and, to prevent climbing, may be cut in pyramid serrations.

For close fencing, 6 in. by 1 in. lapped vertical boards, with alternating shaped tops, are sometimes used.

For rough work, 5 or 6 ft. 3-in. by 1-in. rough sawn, point pickets, set close, are used. This gives a close fence, which opens somewhat when the pickets shrink.

In close fencing, the timbers throughout are usually unwrought.

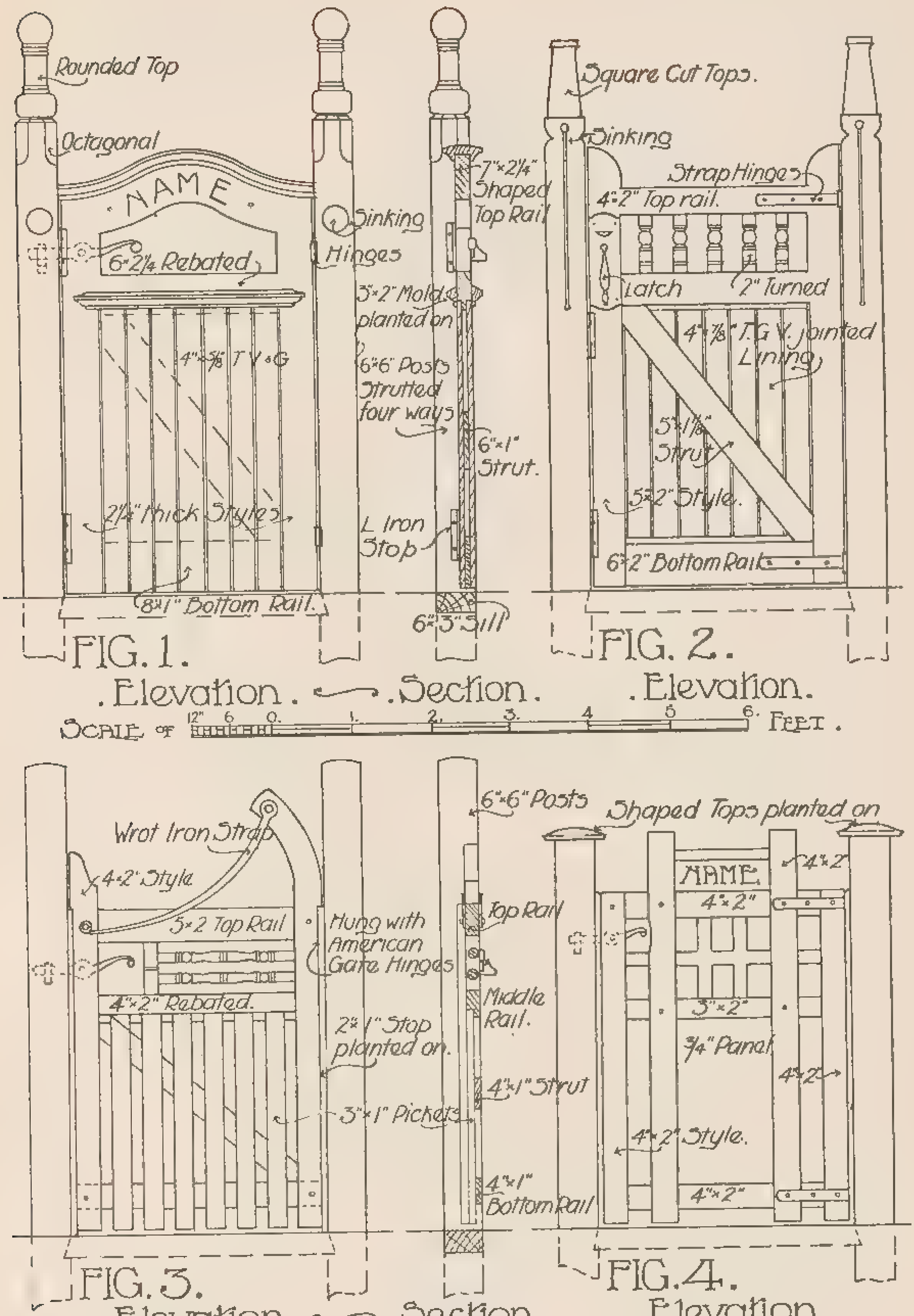
Picket Fencing.—There is very considerable variety in picket fencing.

Picket fencing is generally used to inclose the street boundaries of house properties and is generally of wrought timber. Plate LXXVI., fig. 2, shows a simple picket fence consisting of posts similar to those described for paling fencing, two rails, which are generally sufficient for pickets, and a plinth, which is regulated in depth according to the fall of the ground. In this fence 3-in. by 1-in. and 4 ft. 6 in. long pickets are shown, set 2 in. apart, and secured by two nails to each rail.

Variety is given to this class of fencing by a number of variations. The posts may be ornamented, cut, sunk, or turned and made to upstand above the general level of pickets. The pickets may be cut to shapes, of which there are a great number of stock patterns. They may also be set to sweep lines or interpatterned with smaller or shorter pickets. Sometimes a molded capping is added as a finish. Picket fences are generally painted, or, if of suitable timber, may be well oiled or varnished.

Cart Gates.—The simplest form of gates for fencing is that framed up in skeleton, consisting of styles, rails, and struts covered on one side with fencing material, such as iron or palings.

Cart gates require to be of good width, to suit vehicles likely to pass through them. The posts are best square and stout, being, as the corner posts in fencing should be, stouter than the general fencing posts. Such posts should be strutted and soled four ways, and have a heavy straining sill piece between the posts at the ground



DETAILS OF SINGLE ENTRANCE GATES

level (see Plate LXXVI., fig. 3). In this figure a pair of gates is shown built up with a skeleton frame consisting of styled top and bottom rails and braces. The gates are flush on the one side, being covered between the styles with 6-in. by 1-in. tongued and grooved and V-jointed boarding running right down to the bottom. There is a capping on the top to throw off water, and the gates are hung in pair –*i.e.*, in two leaves, with rebated meeting styles, the support being given by long forged iron strap hinges bolted through top and bottom, having straps on both sides of the gates, and with hook and eye attachments hanging the same to the posts. Such gates require a stop for one leaf at the sill or a bolt upon the gate itself. Securement may be made with pad-bolt and padlock. Some fittings for keeping gates from falling-to when open should also be supplied.

Wicket Gates are sometimes made through other gates to act as pass doors, especially where gates are large, as in stable gates.

Small Gates.—A sheet of designs for single entrance gates is given on Plate LXXVII. Such gates are either fixed at sides of entrance drive gates or to form a foot entry through the front picket fencing.

The simplest form of gate of this type is the "picket gate." This consists of a strong strutted skeleton frame, covered on the outside with open pickets to match the fencing; hung with American gate hinges and fitted with American latch, with battens nailed to the sides of the gate posts to act as stops.

In designing gates, the tendency of the side posts to draw out should be allowed for, especially where strained wire is used in the fencing. In any case the stops upon the posts should be wide and ample, and the latch should have full play, so as to allow of post variation.

Gates may be from 3 ft. to 3 ft. 6 in. wide and of height to suit the adjoining fencing. As they are exposed to outside weather they should be of material capable of withstanding the weather. For this purpose the posts are best of red or blue gum or jarrah.

The gate may be framed up of jarrah or (if not too soft) redwood. If red deal or mild Oregon be used the gate must be well painted and all joints run in with thick white lead.

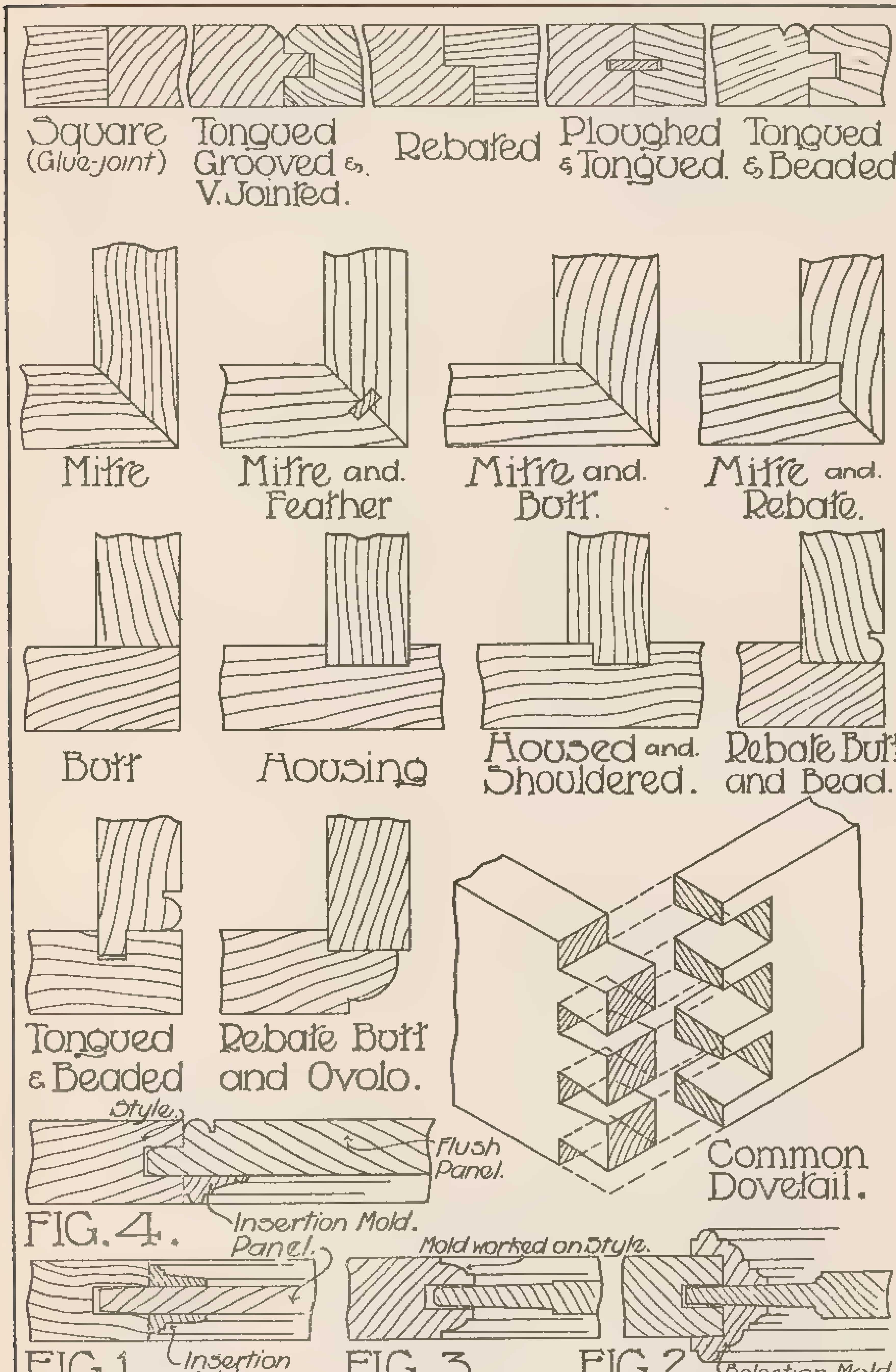
Fig. 1 shows a framed and sheathed gate framed up like a door, with skeleton frame and strut, the top rail being sweeped and capped and of sufficient depth to display the name of the house. There is a shallow, open panel below. The lower portion of the gate is close sheathed with 4-in. by $\frac{7}{8}$-in. tongued and grooved and V-jointed both sides boarding, finished fair outside with mitred capping. The gate is hung with extra heavy American hinges of the type that allow the gate to be self-closing, the latch being of specially made wrought iron. The stops to this gate are made of short lengths of angle iron screwed to the posts.

The section shown will make clear the cross construction. The side posts are 6-in. by 6-in., with turned ornamental tops.

Fig. 2 shows another treatment of a sheathed gate. This gate has an outside visible strut, the spandrels being filled in with boarding and the shallow top panel fitted with turned spindles. This gate is without capping, the styles being carried up above the top rail. The hanging is done by means of strap hook and eye hinges, the lower hinge having double pins for the purpose of self-closing. In this case a Norfolk latch is shown, the stops being of angle iron and the posts square-cut and sunk.

Fig. 3 is a semi-picket gate, with an open frame, mortised and pinned with blackwood pins. Here the hanging style is upstanding, and shaped and fitted with a wrought-iron suspender bolted through the two styles. There are two turned horizontal spindles near the top of the gate, a square space being left at the side for the handle of a wrought-iron latch. In this gate wood stops are planted on to square posts, the section showing the general cross construction.

Fig. 4 shows another character of design. In this case the gate is formed mainly of stout rectangular framing, with mortised and pinned joints. An upstanding panel at the top is reserved for a



· JOINTS IN JOINERY ·

repoussé name plate, the lower portion of the gate being closed in with plain panelling. Here strap hinges are shown, and plain posts with projecting capping.

Joinery.—*Joinery* is the craft that deals with the wood finishings of a building, and, though closely allied to carpentry and adopting many of its methods, has to do more with that highly finished work that requires shop execution, such as the making of doors, windows, linings, framings, panellings, &c. Staircasing is a part of joinery, but is usually executed by special workmen skilled in that class of work. The same is also true of shop and office fitting. Cabinet work, too, is another close ally which, with an ever-growing tendency to make the furniture of a building a part of its natural environment, has much to do with modern practice.

Joints. –Plate LXXVIII. shows enlarged details of the leading joints and connections used in joinery, and should be carefully studied by the student so as to understand the various methods and forms of jointings and moldings adopted, and their technical terms. The mortise and tenon are described in carpentry, as also other joints common to the combined trades.

The plate illustrates such common terms as glue-jointed, T. and G. and V-jointed, rebated, T. and G. and beaded, dovetailed, &c.; also common terms used in framing up doors and panelling, such as flash-panelled and beaded, insertion molded and panelled, bolection molded, &c.

Doors.—The first thought in door construction should be directed to the fact that no door may be made of one piece of wood. Attention, therefore, should be so directed as to use, cut, fit, and contrive the various pieces in such a way that they may make a true and satisfactory framing, directed to withstand the wear and tear that the door is likely to encounter. In this connection, given the size of the door opening, the first consideration is one of suitable timber, and whether the door is for outside or inside use, and what is the nature of the finish.

Outside doors coming in direct contact with rain and weather need to present, as far as may be, a smooth surface to the outside, free as possible from sinkings or moldings where the water may lodge, sink in, and cause decay.

As by far the larger number of doors are made of deal, and "deals" are of limited stock, width, and thickness, the various parts of such doors are arranged so as to cut out of the bulk timber with due economy, and even where doors are made of redwood, or other timbers not so confined to limited size, the traditions and usages of the older system are constantly influencing door construction in the size of scantlings.

Side by side with the question of door construction is the design of the woodwork to which the door has to be hung, and into which the door requires to be set. This work is of two kinds. First there are "solid frames" for outside doors, and "linings" (called jamb linings) for internal doors.

After glancing at Plate LXXIX., depicting common forms of doors, Plate LXXX., showing details of four-panelled internal doors, and Plate LXXXI., with details of joints in doors, we will proceed to consider door frames.

Frames.—Frames for ordinary external doors are made of solid scantlings, usually about 3 in. or 4 in. thick, and of sufficient width to suit walling and plaster. For all ordinary purposes a 5½-in. by 3-in. frame is sufficient, with an increase to 5½-in. by 4-in. if moldings are required on the frame.

In its simplest form the frame consists of two side posts tenoned on top, with a head or lintel piece on top, usually rebated all round to receive the door. Such a frame requires to be firmly secured to the walling, and also to the sill or threshold. If in stonework, this may be done by attached metal cramps or hoop-iron built into the masonry. If in hollow brickwork, wood cleats of corresponding width to the cavity are nailed on. In any case, a frame should be dowelled with galvanized iron into the stone threshold, or stub tenoned at the foot if the threshold be of wood.

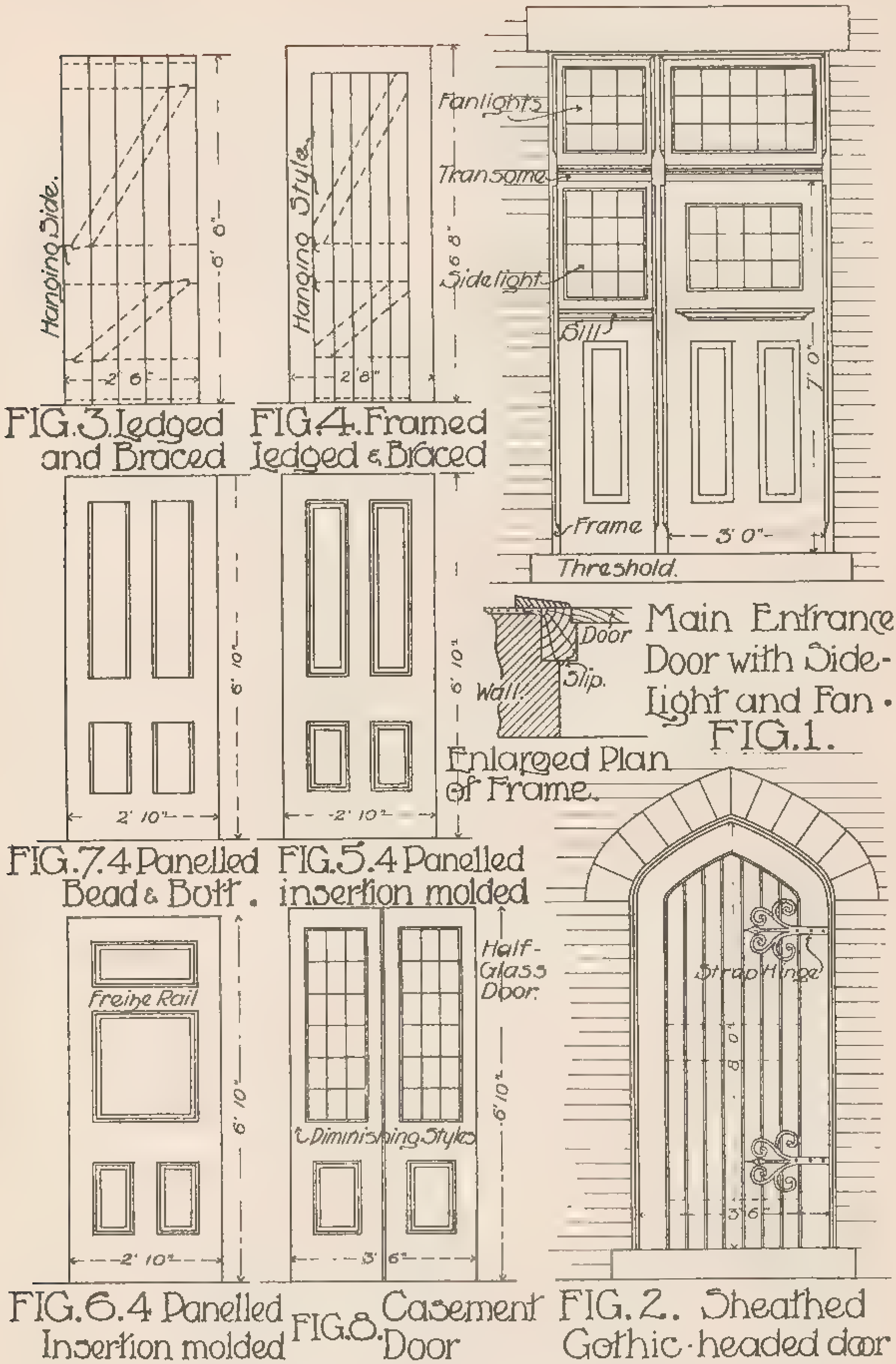


FIG. 1. Main Entrance Door with Side-Light and Fan.

FIG. 3. Ledged and Braced

FIG. 4. Framed Ledged & Braced

FIG. 7. 4 Panelled Bead & Butt.

FIG. 5. 4 Panelled insertion molded

FIG. 6. 4 Panelled Insertion molded

FIG. 8. Casement Door

FIG. 2. Sheathed Gothic-headed door

COMMON FORMS OF DOORS

A superior type of frame is shown in Plate LXXIX., fig. 1; here the frame is furnished with three legs or uprights, a cross sill piece, to take sidelight sash, and a molded "transom," which is a cross beam between the door and the fanlight; here the frame is shown molded, the description of which in specification would read "solid rebated and stop molded frame, with molded transom and sill piece."

In wood frame buildings the frame is usually supplied by an extra thick stud head piece lined with thin stuff, upon which the stops are nailed. Circular head frames are usually cut out of solid in two or more thicknesses, glued and screwed together to form a firm lamination, worked to exact contours required. Fig. 2 shows a door with a Gothic-headed frame, which would be classed as "circular." In shallow segments the visible portion of the frame may be worked fair to curve, and the top left square.

Frames, where they come next plastered walls, are made to stand in front of walling to finishing line of plaster (see the enlarged plan of fig. 1). The frame in this way stops the plaster, the joint being covered by the architrave.

The outside junction of a frame with the walling is best covered with a small wood slip, as mortar stopping does not adhere well to both walling and woodwork. In hollow walls the slip is sometimes extended to stop end of cavity.

Jamb Linings.—As the thickness of internal walls differs, so do the linings required differ in width with them. In half-brick walls the lining consists of a plain board set up plumb against each jamb, and framed into a corresponding headpiece. Upon these, shallow pieces called "stops" are planted; these are usually about $2\frac{1}{4}$ in. by $\frac{5}{8}$-in., and are used to stop the door.

In wide openings skeleton jamb linings are used, such as are shown in detail of four-panelled door (Plate LXXX.) The plan and section shows the lining, which consists of parallel pieces usually about $2\frac{1}{2}$-in. by $1\frac{1}{2}$-in. frame, together with short cross

pieces, and covered with a wide stop. In elaborate work through thick walls the jamb is sometimes panelled and molded.

Jamb linings are usually fixed to plugs driven into the joints of walling. In the best class of work they should be fixed to built-in fixing concrete bricks.

The work of the lining is to hold the door, and, with the aid of the stop, to fair line the opening.

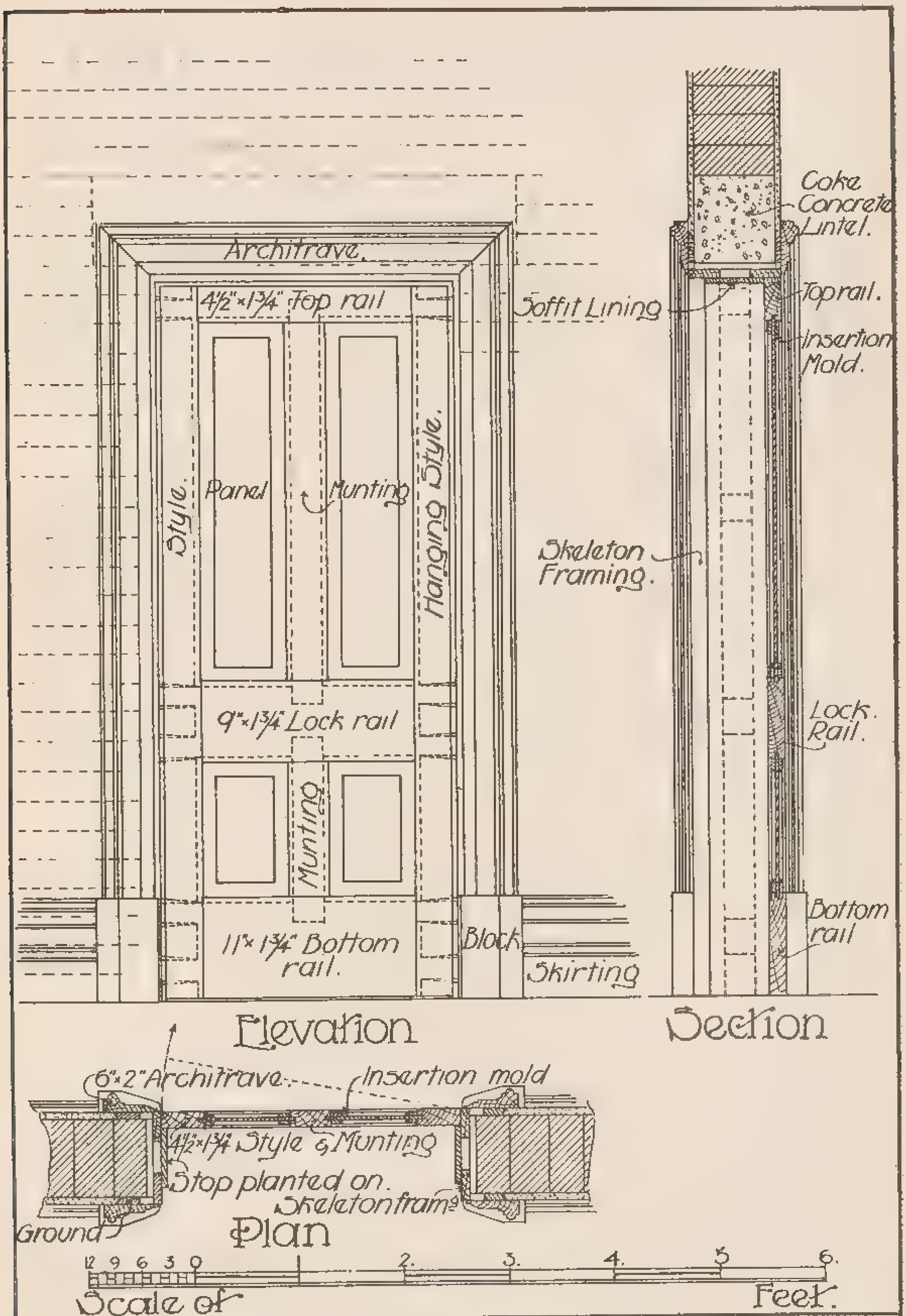
Ledged and Braced Doors.—The simplest type of door is the ledged and braced door (Plate LXXIX., fig. 3), which consists of T. and G. flooring or lining, laid parallel and ledged and braced at the back with plain boarding, clenched nailed on. Such a door is best with V-joints, say 6-in. by 1-in. flooring, or 4-in. by $\frac{3}{4}$-in. lining, with 4-in. by 1-in. top ledge and braces, 6-in. by 1-in. middle ledge, and 7-in. by 1-in. bottom ledge. Such a door is only suitable for wooden outbuildings and similar positions.

Frame Ledged and Braced Door (Plate LXXIX., fig. 4), is a superior class of outside door having a skeleton frame, say, $\frac{3}{4}$-in. thick, with 5-in. by $\frac{1}{2}$-in. wide styles and braces, 9-in. middle rail, and 10-in. bottom rail, all mortised and tenoned together. The styles and head are rebated to receive 4-in. by $\frac{3}{4}$-in. T. and G. and V-jointed lining, which covers over the braces and middle and bottom rails, which consequently only show at the back of the door. This class of door is often used for wide openings in pair, in which case the meeting styles require to be rebated.

The tenons for this type of door are shown in detail by Plate LXXXI., fig. 1.

It will be specially noted how that the middle and bottom rail tenons are called "bare-faced tenons."

Sheathed Gothic-headed Door. — A somewhat similar door is shown in Plate LXXIII., fig. 2. This door may, if required, be made to look the same on both sides by both outside and inside sheathing, the middle and bottom rails being sandwiched in between the sheathing and tenoned into the styles, a type of tenon that is used when the rail is of less thickness than the style into which it is



DETAILS OF A 4 PANELLED INTERNAL DOOR

mortised. The tenon is bare one side—*i.e.*, fair with the surface of the rail.

Ordinary Four-panelled Door.—The four-panelled, stock-patterned, internal insertion molded door is the most universally used of all doors, and is purchasable ready made in sizes as follows:—6 ft. 6 in. by 2 ft. 6 in. by $1\frac{1}{4}$ in.–$1\frac{1}{2}$ in.; 6 ft. 8 in. by 2 ft. 8 in. by $1\frac{1}{4}$ in. –$1\frac{1}{2}$ in.; 6 ft. 10 in. by 2 ft. 10 in. by $1\frac{1}{2}$ in.–$1\frac{3}{4}$ in.; 7 ft. by 3 ft. by $1\frac{3}{4}$ in.–2 in.

This class of door is shown in Plate LXXIX., fig. 5.

The construction of a well-made panelled door is fully illustrated on Plate LXXX., the tenoning being shown to enlarged size by Plate LXXXI., fig. 2.

By reference to Plate LXXX. it will be seen that a panelled door is made up of a frame infilled with grooved-in panels. This frame is mortised and tenoned together in every part, and is cramped up and shut around the panels, the junction of the panels and the frame being infilled with moldings, called, if below the surface of the styles, "insertion molds" (Plate LXXVIII., fig. 1); if projecting above, "bolection molds" (fig. 2). This framework around the panels is divided into various parts. The two side pieces running from top to bottom are called "styles." There is the hanging style, upon the side the door is hung, and the outer style. These styles receive the various cross rails —the top rail, the middle or lock rail, and the bottom or lower rail. In the case of extra panels, as in Plate LXXIX., fig. 6, a frieze rail may be added.

Central upright pieces divide the panels; these are called "muntings," and are tenoned into the rails. All the styles, rails, and muntings are in their turn plough-grooved out, in order to receive the panels, which are thinner than any other part of the door.

Mortising and tenoning for this class of work is invariably done by machinery, the various tenons being best arranged as shown in Plate LXXXI., fig. 2, before referred to.

Mortise holes are cut and splayed slightly towards their outer edges, so as to allow of insertion of wedges. On the bottom rail two single tenons are shown, with haunching between, to stop daylight showing should the door shrink. In the lock rail there are two double tenons, with haunching so arranged as to receive mortise lock without cutting away too much of the door substance. The top rail has a single tenon and haunch. The various parts are put together, all tenons glued, panels left free, and the whole closely cramped up, and the various tenons end wedged with wedges dipped in glue.

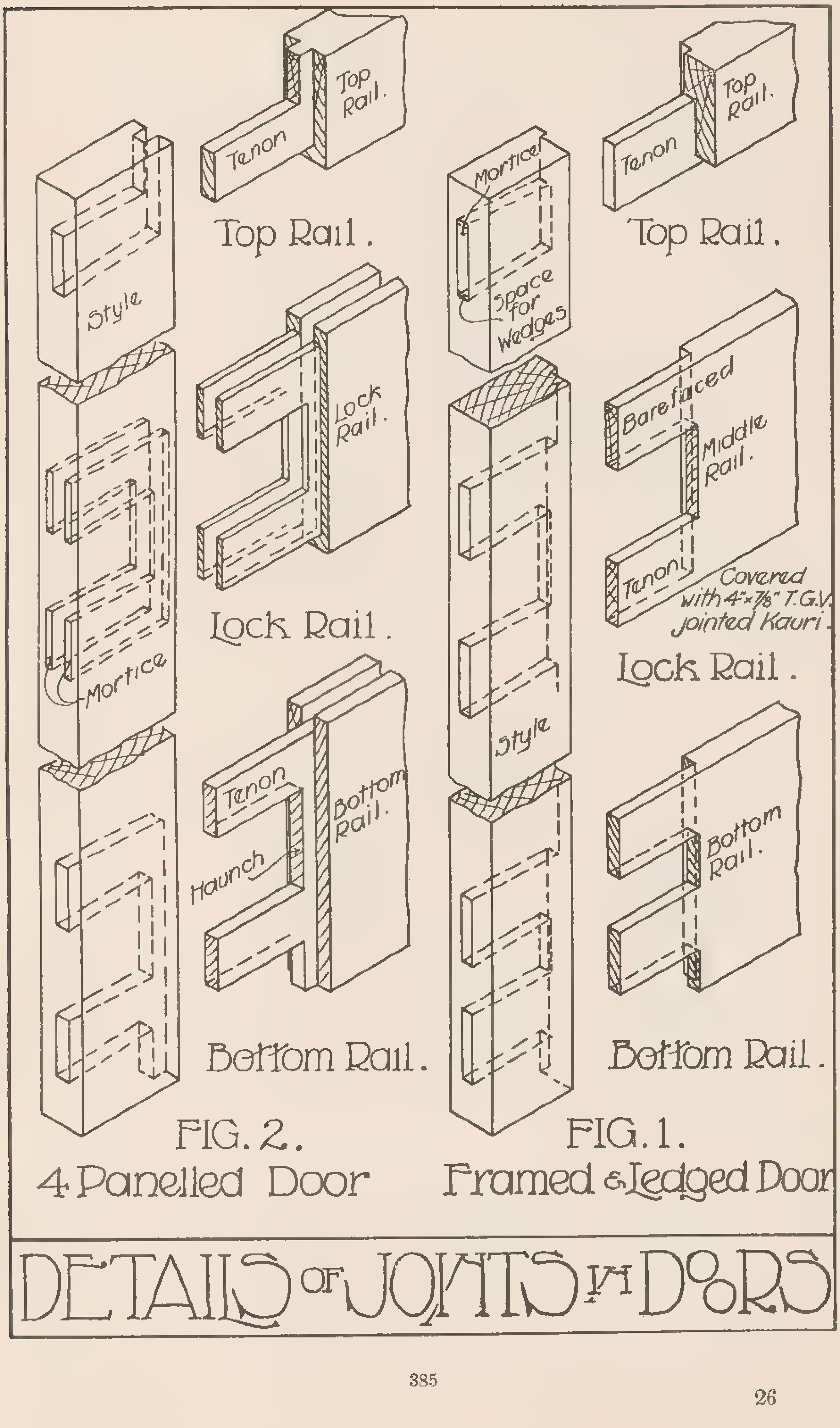
Framed doors should always be made at the commencement of building operations, and loosely put together and set aside for seasoning. Just before being required, the joints should be glued up, tenons wedged, and the whole cramped up, mitres of molds cut and shot and set true, and the door fair cleaned off, ready for delivery and use.

Another form of the four-panelled door is shown in Plate LXXIX., fig. 6. Here a broad central panel is made, surmounted by a long, shallow top panel. Several variations of this type of door may be adopted where doors are specially made, the general principle of construction being the same as for the ordinary four-panelled door described above.

Details showing how the panels are inserted and molds applied are seen in Plate LXXVIII., figs. 1, 2, 3, and 4.

Bead and Butt Doors.—A serviceable door for plain outside positions is made on the flush-panelled principle—*i.e.*, framed up in panels, but with the panels rebating and showing quite flush with the outside of the styles and rails, so as to give no lodgment for water.

Such a door is either "bead butt" (Plate LXXIX., fig. 7), which is when the bead at the joint of the panels and styles runs vertically only, or "bead flush," when the bead runs all round the panels. The inside of such a door may be without moldings, in which case it is described as "square framed" inside, or it may be insertion


Tenon
Top Rail.
Top Rail.
Style
Lock Rail.
Lock Rail.
Mortice
Tenon
Haunch
Bottom Rail.
Bottom Rail.
Mortice
Tenon
Top Rail.
Top Rail.
Space for Wedges
Barefaced
Middle Rail.
Tenon
Covered with 4"×7/8" T.G.V. jointed Kauri.
Lock Rail.
Style
Bottom Rail.
Bottom Rail.
FIG. 2.
4 Panelled Door
FIG. 1.
Framed & Ledged Door
DETAILS OF JOINTS IN DOORS

molded, like ordinary four-panelled doors. The panel insertion for this door is shown in detail by Plate LXXVIII., fig. 4.

Casement Doors.—A type of door useful in providing both light and access to apartments opening upon verandahs is the casement door (Plate LXXIX., fig. 8). These may be single or in pair. The figure shows a pair of doors with rebated and beaded meeting styles. It should be noted that here the styles are "diminishing." This is done to give extra expanse for glazing, the style being bevelled from its width at the lower panels to its narrow width next the glass. Glass in these doors is secured with wood beads or slips, and may be in leaded glass, strengthened with round iron rods. If sheet glass be used molded and rebated cross sash bars should be placed across the openings to divide up the space, otherwise the concussion of the door would tend to fracture so large a sheet of glass as would be required for the whole opening.

Of similar character is the numerous variety of doors classed as "half-glass doors," so very largely used in commercial building, as well as in passages and positions where light is required to pass through the door.

Main Entrance Doors.—The door or doors serving the main entry of a building are usually designed with regard to the special importance of such a position, and require to take upon themselves some dignity and suitability in accord with the character and style of the building served. In commercial buildings the outside enclosure is not infrequently occupied by an iron collapsible or hinged gate, at the back of which the doors are arranged. In important buildings such doors are often of large size and elaborately molded, for though the principle of panelled door construction remains very much the same, yet almost every part of a door may be varied and differently treated. The moldings may be elaborated and even carved, the panels may be raised, bevelled, or enriched, and moldings and cut woodwork of various kinds may be attached to the rails. The frame, too, may be greatly elaborated, and especially the transom. "Overdoors,"

too, are not infrequent. These are ornamental, pedimental, or other decorative forms, crowning the door or the door and fanlight.

A simple house main entrance door, with sidelights and fanlight, is given in Plate LXXIX., fig. 1. Here a 7-ft. by 3-ft. half-glass door is hung in a molded frame (described under frames). There is one sidelight made up below of framing to match the door, a molded sill and sash above. The fanlights consist of sashes made in the usual way as described in "windows," are secured within the rebate of their frame, and may be hung either top, bottom, or at the side. Domestic front entry doors more often have two sidelights. Space, too, may be required for letter plate, bells, &c., and the design may be greatly varied to suit special circumstances.

The glass for such a door is best in lead, and may be of semi-obscure, fancy, or colored glass. The fanlight glass may well be occupied by either the number or the name of the house to facilitate identification at night.

Fly Wire Doors.—External doors often require to be supplemented by fly wire doors. These are made to open the opposite way to the ordinary door, and may be hung upon the same side and to the same frame. A fly wire door is best made of 1¼ in. or 1 in. thick stuff, with framing exactly the same as the ordinary door, but lighter in general width, and with the panels left out. The panels are then covered with well-stretched galvanized iron or brass fly wire, close tacked down, and covered all round with light wood slips, mitred at angles. Such doors are best fitted with a spring, to ensure their close fitting, and may also be hung with loose, pin-butt hinges, so that they may be readily taken off and stored during winter months.

Trap Doors.—Doors of various kinds are used to give access through floors to cellars, &c., also through ceilings to roof space; these are best kept as light as possible and so hinged as to be stable when used and not liable to fall without warning. Floor traps are

made to flooring ledged on the underside. To make a close job of hanging, the boards may be "clamped"—that is, grooved at ends—into a cross strip of timber, thus showing side grain all round. In this way butts may be used instead of tee hinges. Such traps are best fitted with flush sunk ring and flush bolt. Ceiling traps may be made, similarly fitted into a trimmed, lined, and rebated opening.

Trap doors through roof covering require to be covered with lead or sheet iron, which renders them both awkward and heavy. These are sometimes made to slide on rollers. If hinged, strong wrought-iron stays, for keeping the top open, should be fixed, and special provision made at all times for keeping out the weather.

With regard to all trap doors some effort should always be made to provide light to them, and this can generally be done if attention be directed to such a need in the planning.

Ironmongery for Doors.—Hinges.—Ordinary framed and panelled doors are usually hung with "butts"—*i.e.*, butt hinges. For any of the stock pattern doors a pair (or, better, three) 4-in. iron butts are used, sunk into the door and frame or lining and countersunk screwed. There are numerous other kinds of butts, such as "brass butts," "brass bushed butts" (*i.e.*, with steel bearings), "two-way butts" (that allow a door to work both ways), "loose slip pin butts," "gun-metal ornamental butts" for polished work, and others.

For ledged doors and gates tee hinges are used, while for framed doors and gates of extra width wrought-iron strap hinges are best (Plate LXXVI., fig. 3). In church or ecclesiastical work the ornamental wrought-iron scroll hinges may be used (Plate LXXIX., fig. 2).

Where traffic is considerable doors are often hung to swing. These are fitted with sunk, floor spring hinges, which clutch the door by means of a metal plate, the concussion of such doors being often relieved by straps.

Locks.—Common locks for ordinary internal doors are either rim

locks or mortise locks, and act both to catch and to lock. A rim lock is made to fit upon the outside of the door, the mortise lock being sunk within the thickness of the door. In addition there are rim and mortise latches. Dead locks are usually of heavy pattern and act as bolts only (not catches). Drawback locks may be used for outer doors. These have a handle or drawback bolt action on the inside. Panic locks, only adjustable from inside and released by drawback action, are used for public assembly buildings. Locks are described by their length and make.

Furniture.—Door handles are usually allowed for as separate articles from the lock itself, the term "furniture" being commonly applied to handles or handles and finger plates, key-hole escutcheons, letter plates, knobs, &c. There are a very great variety of every kind of such articles purchasable in the market ready for fixing.

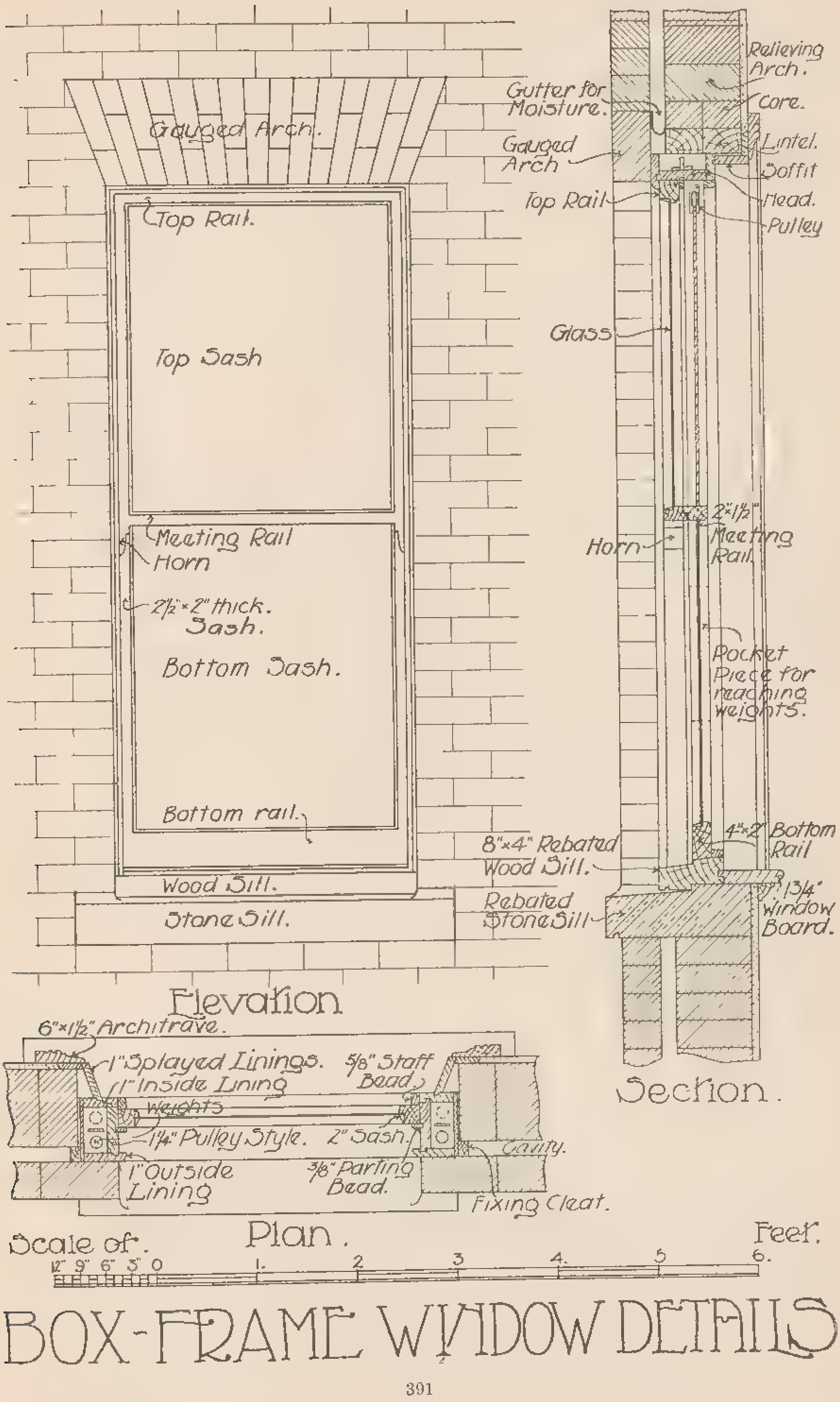
Bolts.—In addition to locks, bolts are usually fitted to outside doors. Of these there is a variety. The "tower bolt" is a simple bolt, working through metal guides. In the "barrel bolt" the bolt works along a closed-in barrel. The "monkey-tailed bolt" has a specially long end or tail, and is often used to bolt the top of a door. Then there are "flush bolts" that sink flush into the body of the woodwork; and "double-action bolts" in metal casings, reaching from top to bottom of a door, and adjusted by a central knob handle. These latter are used chiefly for escape doors in public buildings, and are sometimes called "espaniollettes."

Bolts are described by their kind and length.

WINDOWS.—Windows may be divided into two broad classes—"box" frame windows and "solid" frame windows.

Box Frame Windows.—The constructive details of a box frame window are shown on Plate LXXXII. From this it will be seen that a box frame window, or, as it is commonly termed, a "double-hung window," consists of sashes sliding in grooves held and lifted by weights and cords working in a hollow box or frame.

PLATE LXXXII.



BOX-FRAME WINDOW DETAILS

The frame consists of a sill, which should be of timber capable of withstanding the weather, "weathered" on top and rebated over stone sill underneath. The sash frame consists of "pulley styles," "outside lining," "inside lining," rough "backing," "parting beads" to keep the sashes apart, and "slips" to separate the weights. A bead around the inside lining keeps the sashes in position, and there is a head-piece to take up with pulley style at the top. All these parts are framed together and to sill, the pulley styles being tongued into the inside and outside linings, the parting slips ploughed in, and the backing nailed on. In this example, which is fixed in a hollow brick wall, cleats are secured to backing, and built into a cavity for fixing the frame to the walling.

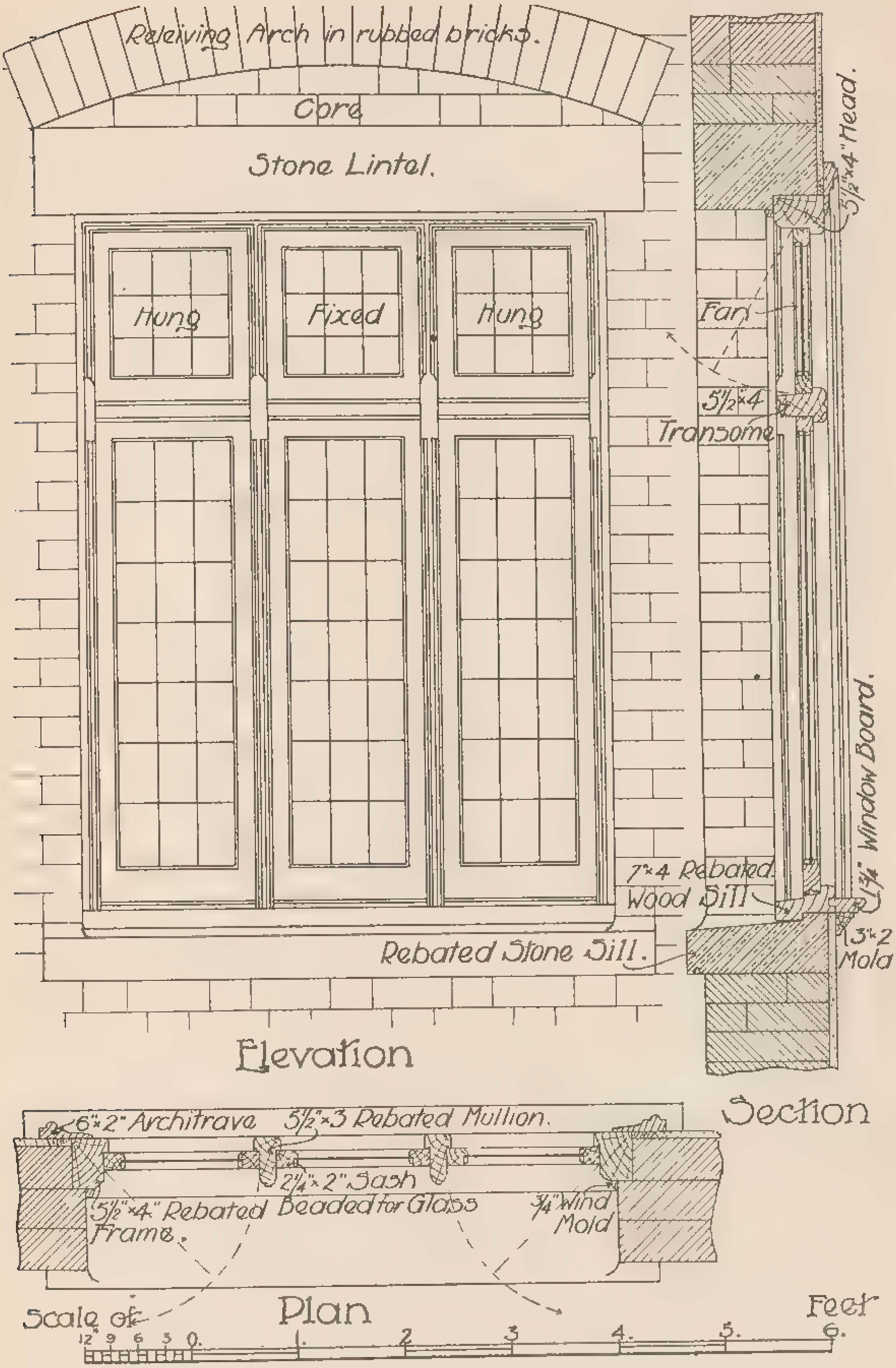
The sashes are made in pairs, and are described by their thickness, such as $1\frac{1}{2}$-in., $1\frac{3}{4}$-in., 2-in., &c. They consist of mortised side pieces, into which the cross rails tenon in very much the same way as a door is framed. The top or upper sash has the top and two sides equal; the meeting rail, being somewhat less in depth, is rebated or splayed to meet with the corresponding rail from the lower sash, and to make a close joint. The side pieces of the upper sash are usually extended downwards and molded; these are called "horns." The bottom or lower sash has a bottom rail deeper than any other rail in the window, which is splayed or rebated to fit over the wooden sill. Grooves are sunk in the sides of sashes into which sash cords are firmly secured. These cords are on either side, and are passed over and through metal axle pulleys sunk into the pulley styles. The cords are attached to long, round cast-iron weights, which work up and down in the box frame. These weights require to correspond with the weight of each sash when glazed complete, for which purpose the sashes are scale weighed and the weights adjusted to correspond. In very large windows or where extra heavy glass, such as plate glass, is used, the weights require to be of lead. Steel ribbons may, in such cases, be employed in place of cords. A hinged pocket piece should be arranged in each pulley style,

through which the weight may be reached in case of repairs being required.

Solid Frame Windows.—All windows other than box frame windows may be classed as "solid frame" windows. These are of various kinds, the general principle of which is that a solid frame is made to receive the glass direct, or to hold the sash containing the glass. In shop front windows the solid frame is made to hold the glass direct, which is adjusted in beads only (see "Shops") This class of practice is, however, limited, and is only possible where lights are fixed; when windows require to be opened, a sash is interposed and fitted into a rebated frame.

Casement Windows.—Details of a solid frame casement window are shown in Plate LXXXIII. This diagram illustrates in detail the usual application of a solid frame window with sashes. The plan shows a 5½-in. by 4-in. solid, rebated, and ovolo-molded frame, with 5½-in. by 3-in. rebated and molded mullions and 5½-in. by 4-in. ditto transom, and 7-in. by 4-in. weathered and rebated sill, which are all mortised and tenoned together, and secured to brickwork with iron cramps screwed to the sides of the frame and built into the work. This frame receives the sashes, which are made separately and rebated, molded, mortised and tenoned together. In this case the sashes are filled with leaded glass, so require to be fitted with "beads" or "slips." Where sheet glass is used the rebate only is made and left for glass and putty. The fanlight sashes are made in the same way as the lower (casement) sashes. Casement windows in exposed positions, subject to the action of driving rains, require to be specially designed and very carefully fitted, as they do not offer the same amount of general protection against the weather as the box frame window. Care should be taken to have the frame deeply rebated, a groove ploughed out to check capillary attraction of water drops, a "drip" at the transom to prevent moisture entering over the top of the casement sash, and the fan so hung as not to let in the rain. Sills should be carefully looked to, and should be steep and with full check.

PLATE LXXXIII.



DETAILS OF CASEMENT-WINDOW.

Casement sashes are hung in a similar way to doors, usually to open out, the fans being hung either top, bottom, side, or on pivots from a centre.

This diagram also makes clear the principle of sashes in solid frames generally, which is variably applied in single or many light windows of all shapes and sizes. A frame may contain one sash only, and be pivot hung, in which case the stops require to be planted on, or the frame may be circular segment headed or square, the general construction remaining very much the same. In high-class stone buildings metal casement frames and sashes specially manufactured for the purpose are often used; these occupy the minimum of space, and allow for a maximum of glass area in the opening.

Window Boards and Linings.—The inside finish of a window near the sill is usually made with a "window board." These are boards tongued into the wood sills, projecting beyond the inside wall covering, and finished with rounded or molded edges and a small bed mold.

On Plate LXXXIII. the window is what is termed "flush with inside of wall," consequently, the window board is shallow and only of sufficient width to project slightly beyond the architrave. In Plate LXXXII. the window is set in the centre of the wall, which arrangement creates a recess inside, which requires to be lined. This is done with a "splayed window lining" tongued into the inside box frame. Linings are either set at right angles to the window, in which case they are called "square linings," or splayed as shown in the figure, when they are known as "splayed jamb linings."

Patent Windows.—Several patent windows have been placed upon the market, directed chiefly to overcome the various disadvantages of ordinary windows, and specially to add facilities for cleaning the glass without reaching to the outside of the apartment, or for ventilating without draughts. Some of these are only suitable for institutional buildings, others being directed more for domestic use.

Frameless Windows.—In public buildings, especially in ecclesiastical work, windows may be arranged at times without frames. This is done by inserting leaded lights into a groove or "raglet" in stone or cement jambs or mullions. In this way, strengthened by cross bars, narrow lights are able to carry without being set in frames. For this class of work, where ventilating hoppers are required, they are made with very light metal frames to hold the working parts, which may consist of a hinged glass lid, hung with pulleys, and adjustable hanging balance weights.

Ironmongery for Windows.—Ordinary double-hung windows require to be fitted with some suitable fastening fixed at the meeting rails, also with a pair of ring lifts, attached to the inside of the bottom rail, for lifting the bottom sash. In heavy windows the top sash outside may also be fitted upon underside of meeting rail with ring lifts. In window fittings a very large number of purchasable devices are directed to secure lockment of the sash when it is partly open, and specially secure it from outside approach.

Pivot-hung windows require metal pivot attachments, with pins upon the sash, working in metal sockets sunk in the frame. These windows are usually secured with spring shooting bolts and cords.

Fanlights are usually hung with "butts," and fitted with metal fanlight openers, which act both as lock and stay, and of which there is a very great variety. The simplest way is to attach a short length of chain to the side of the frame and the top of the sash, and to open and close with cords working over eyes or pulleys. Casements are hung with "butts," and may be fitted with casement hooks and eyes or casement stays attached to sills. The locking of these is usually done by means of a casement fastener, adjusted to frame and sash at hand height, which acts as both handle and lock.

Outside Venetian Shutters.—To windows with a sunny aspect, and specially to windows facing west and north, not protected by

verandahs, outside Venetian shutters are sometimes fixed. These consist of a skeleton frame, similar to a door, hung usually in pairs, to a lining at reveals of window openings, and having rebated meeting styles. A suitable shutter for an ordinary window is made with $1\frac{1}{2}$-in. stuff, having 3-in. styles and top rail, 4-in. intermediate, and 5-in. bottom rails, the infilling being of light rounded edged louvres, $1\frac{3}{4}$-in. by $\frac{3}{8}$-in., set $\frac{3}{8}$-in. apart, at an angle of 60°, and machine housed into the style.

These shutters require to be hung with stout parliamentary hinges, to throw shutter out and flat back against the wall, and should be fitted with locking bolt and adjustable wall stays.

Stair-Building.—Wooden stair-building is a craft by itself, usually carried out by staircase hands, craftsmen specially skilled in this class of work,

A stair is a device for giving walking access to floors which lie one above the other, and in principle is always the same, consisting of steps grouped together one above the other. (See Stone Stair, Chapter XI., Plate LVI., fig. 3, and Iron Escape Stair, Plate LXIV.)

Staircases differ greatly in form, size, design, and finish, according to the position they occupy, the range varying from ordinary outside steps, or plain back stairs, to the elaborately detailed main stairs of halls.

A wooden stair in its simplest form consists of two "strings"—*i.e.*, two deep boards set up edgewise and parallel, at a given width apart, at a raking angle, into which cross treads, or treads and risers, are housed (see details, Plate LXXXIV., figs. 1 and 2). A string, if next a wall, is called a "wall string;" if upon the outside, an "outer string."

Outside open riser stairs, or steps as they are generally termed, usually consist of plain strings, say about 12-in. by 2-in., having 10-in. by 2-in. round-nosed treads, housed in with a "rise" of 7 in. and a "going" of 8 in. The strings are secured at foot into

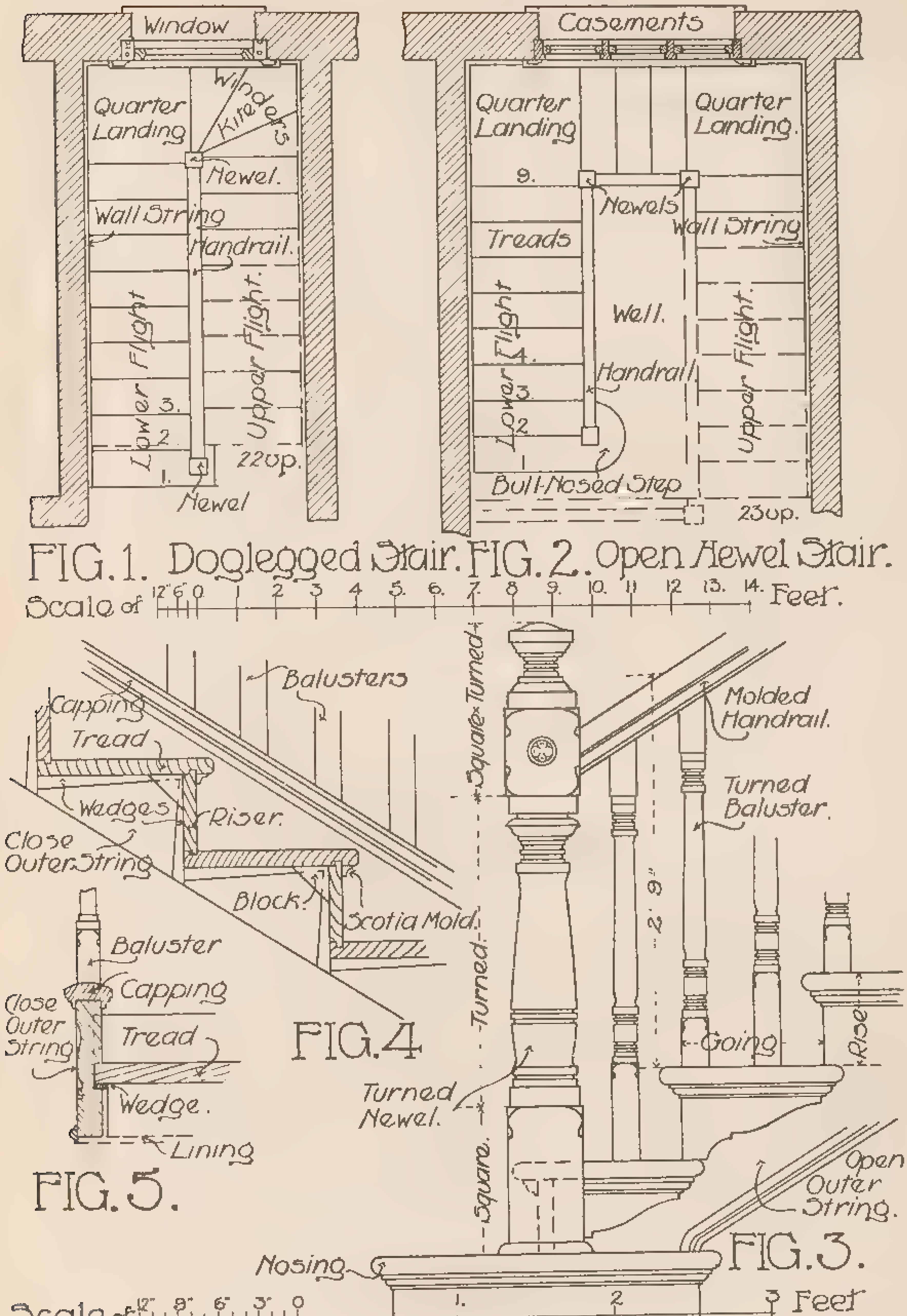
a ground sill, and at top into a landing or walling. A simple handrail and uprights or newel posts are fixed if the flight is at all considerable. Such a stair is usually attached to wood frame buildings, when they are built up above ground level, and well illustrates the simplest form of stair.

Setting Out.—In setting out a staircase regard must chiefly be given to ease of "going" consistent with the space available. The height from floor to floor is taken, landings, ease of access, lighting, head room, &c., provided for, and steps, both as regards their "going" and "rise," worked out. For general work a tread of about 11 in. with a rise of 6½ in. gives an easy going, and some proportionate ratio of this kind is best kept. Flights of more than about fourteen risers should be avoided and easy landings introduced at intervals.

Where space is confined "winders" are used, but these are not recommended.

Reference should be made to Plate LXXXIV. for details and particulars of technical terms connected with staircase building. Fig. 1 on this plate shows a simple dog-legged stair—*i.e.*, a stair in which the flights touch each other. Where there is space between the flights, as in fig. 2, it is called a "well." Note the explanation of the term "going" (fig. 3). The going is the subdivision of the flight into so many equal parts, and represents the space allowed for the treads in the setting out. The nosings of the tread usually project beyond the going. In open riser stairs the going may be reduced as is done in outside wooden steps. Fig. 2 shows the setting out of an open newel or well stair where greater width is allowed. Such a well, besides giving more space in the stair, enables light from an upper window to shine down the stair more freely than in the dog-legged type.

Staircases are sometimes built entirely upon uprights, at other times being without internal support save from floors, landings, and walls. There are also circular stairs, or stairs circular in some of their parts.



STAIRCASE DETAILS

Strings and Steps.—Strings are of two kinds, "close" and "open or cut." A close string consists of long lengths of timber (which may be molded, capped, or enriched) into which the treads and risers are housed, glued, and wedged, as shown in Plate LXXXIV., figs. 4 and 5. Note here how the treads are worked and rebated into the risers, the nosings being rounded and fitted with a small under mold. The treads and risers are strengthened and held together along their length on the under side with blocks glued on at intervals.

An open string is shown in fig. 3. This string is cut out to receive the treads, upon the top of which they rest. Such a string is applied to the outer string of stairs only.

Strings require to be firmly framed top and bottom, usually into newel posts.

Circular strings are formed of laminated boarding, bent and weathered round a drum—*i.e.*, a shaped, built-up block or pattern kept for the purpose.

Wall strings may be molded or ramped to continue the line and contour of skirtings from floor to floor if desired.

Treads out of solid are sometimes used for semi-fireproof stairs, for which purpose slowly burning timbers are employed.

Carriages.—In wide stairs a rough scantling is placed from top to bottom of each flight along the central under side of the steps to stiffen and to carry them. This piece of timber is called a carriage.

Newels.—Upstanding vertical posts are placed at the ends of flights to receive handrails. These are called "newels," and may be square, molded, carved, or turned. Newels are sometimes made "continuous" from floor to floor, or cut short and molded near the landings or upper floors, in which case the visible lower ends are termed "drops."

Handrails are usually molded in various ways, or, in plain work, half-rounded. In place of newels at the turn of a stair, handrails are sometimes curved and continued, in which case they are said to be "wreathed."

The normal height of handrails is 2 ft. 9 in. from edge of tread. Upon landings or returns on level upper floors this should be increased to 3 ft. or more. Where handrails die into walls without newels, a wooden wall-block requires to be allowed for in the fixing.

Balusters.—The infilling pieces under the handrail are called "balusters." These may be square, turned, or finished in various ways.

Landings.—The wells and landings of stairs are usually trimmed in the same way as floors, joists being framed in and floored, all visible parts being wrought or lined.

Soffits.—The under sides of stairs are sometimes invisible, owing to the spaces under them being enclosed down to the flooring below. This is called "spandril" framing. When the actual soffit of a stair is lined it may be lathed and plastered, wood lined, panelled, or covered with embossed metal.

What should be aimed at in staircase building is ample spacing, ease of going, good lighting, and rigidity of construction.

LININGS.—Linings usually consist of boarding, cut and dressed for the purpose. Where lining is laid over the whole area of a roof, immediately under the roof covering, rough boards are usually employed. This is called "rough lining," and is generally of 9-in. wide spruce or Pacific pine. Inside linings of good class work, such as ceilings of halls or apartments, soffits of stairs, &c., is usually carried out with hand-dressed T. and G. and V-jointed boarding, the stock sizes of which are 4-in. by $\frac{1}{2}$-in. or $\frac{5}{8}$-in. This should be close-fitted and fixed with finishing nails well punched in, the end joints being splayed to prevent daylight sighting when shrinking.

A common kind of lining in use is the imported Baltic lining, such as 6-in. by $\frac{3}{8}$-in., $\frac{1}{2}$-in., or $\frac{5}{8}$-in. T. and G. and beaded lining boards.

Finishing linings always require small molds at all angles to

make a clean finish, and should have fixings about every 18 in., or not more than 24 in. apart.

PANELLING.—Panelling is made up much in the same way as door panelling (see Doors), save that for positions such as "wainscoting" round apartments, "spandrils" of wooden stairs, ceilings, soffits, &c. It is only finished fair on one side, and consequently the framework is less in thickness than in door work. Size and shape of panels and class of molds and finish are made to suit the work. To give the full appearance of thickness, the panels are sometimes rebated at the back of the frame, or the panels may be lapped and screwed entirely at the back of the frames. These arrangements leave a deeper front recess for the panels, which adds to the boldness of the effect.

Panels are sometimes made of T. and G. and V-jointed boarding or in parti-colored woods.

In office or bank fittings, panelling for screens is usually fair on both sides, like doors, and requires to be strengthened by uprights or rails.

CASINGS.—Rough beams, rolled steel joists, pipes, &c., are usually cased in, frequently with wood. These may consist of plain boarding with ovolo-molded and T. and G. edges, secured at distances of about every 24 in. to "firring pieces"—*i.e.*, rough batten cradling.

MOLDS.—Moldings are usually "run" by machinery, which may now be easily set to any contour. If moldings are large, they are best "built up"—that is, made in two or more widths, and secured to rough backing. In designing moldings care should be taken to secure the best effect, and the proper projection and shadow for the molding in the position it is to occupy, whether near the eye, or at a distance or height; also that the molds should be in keeping with the style of architecture adopted.

Picture molds are usually of wood, with a top rounded member

to receive the metal cord holders. These molds are usually secured to walls through wood plugs; specially heavy pictures, however, require metal rods and specially secure fixings.

A mold is said to be "planted on" when it is added separately to the work. When it is worked upon the actual material to which it is applied, it is "stuck on."

Molds are usually mitred at external angles, and "scribed" at internal angles—that is, the contour of the one piece is cut out to fit against the other piece running at right angles.

Grounds are continuous battens to which joinery is fixed. For narrow skirting or around architraves in plastered walls, the plaster is allowed to finish up against a splayed ground, which is afterwards covered with the finished woodwork. Grounds are fixed with plugs to walls.

Architraves.—An architrave ground is shown in Plate LXXX., and a skirting ground in Plate LXVIII.

"Plugs" are rough-cut, tapered pieces of wood driven or built into joints of walling, afterwards sawn off fair, and are used in the fixing of joiners' work; they should be about every 18 in. apart centres.

Joiners' work is usually put together with glue and finishing nails. For special work screws are used, which, in the case of polished finishings, may be made of brass or nickel in cups.

Architraves are plain or molded lengths of woodwork, secured as frames around the doors and windows, to cover the joint between the frames or lining and the walling. The stock sizes of molded wood architraves are—4-in. by $\frac{7}{8}$-in., 5-in. by $1\frac{1}{4}$-in., and 6-in. by $1\frac{1}{4}$-in. These are sometimes set up on "skirting blocks" (Plate LXXX.)—*i.e.*, shaped pieces designed to stop the skirting and to act as a pedestal for the architrave. Square block ornamental corners are also sometimes used at the top angles of architraves. The term "architrave" is applied equally to wood, stone, plaster, or brick finishing around doors or windows.

Skirtings.—Skirtings consist of continuous boards, usually molded, set around an apartment at the lower portion of the wall, next the floor. The stock sizes of skirtings are 7-in. by $\frac{3}{4}$-in., 9-in. by $\frac{7}{8}$-in., and 11-in. by $\frac{7}{8}$-in. Skirtings are sometimes extra deep and on receding planes in height, when they are called "double-faced skirtings," in addition to which molds may be added on top, when they are termed "D.F. and molded on top skirtings." Deep skirtings of this latter character are fixed to "soldiers"—*i.e.*, shaped upright pieces upstanding against the walls, plugged and secured to walling at distances of about 18 in. to 24 in. apart. These take the place of the "grounds" used in narrow skirtings.

Fittings.—When the structural part of a building approaches completion, the fittings require to be fixed and the joiner's work of finishing carried out. In business premises, shops, offices, and banks fittings of an extensive and elaborate character are often required; these vary greatly according to the conditions and requirements and the amount of floor space and light available. These may not be specially touched upon here; some mention may, however, be made of a few common problems that have to be allowed for in the carrying out of ordinary work.

In fittings of every kind only the highest quality and driest timber should be used and hand-dressed throughout. In fancy and special woods the various parts should be skilfully matched and the best figurings reserved for the panelling. Even with dry timber fittings are best cut out and allowed to stand to season before being finally put together, so as to secure close and sound joints. For polished finishes the hard, dense-grain woods are best, and these require to be specially prepared for the finish, and preserved clean and free from damage. Any nailings must be "secret," and fixings made as far as possible invisible. Panels are best left loose, counter tops buttoned down (not screwed), and guard rails placed against framing liable to be kicked or scratched.

The process of wear that takes place in framing near the floor from the sweeping and cleaning of the floors calls for some attention. Glass, too, should be put in so as to avoid concussion, and especially in draughty positions, or in or near doors likely to slam. In such positions lead lights are liable to bulge, and over-large sheets to fracture, unless arranged, sized, and guarded with skill.

Elevator and stair screens are best left without glass and panelled, finished with wire or open metal work.

Cupboards, Wardrobes, &c.—Cupboards, wardrobes, stores, &c., with wooden fronts are usually made with an inside skeleton frame fair lined on the outside or fitted with panelled framing to match the doors. In such fittings a false floor should be put in a few inches above the ordinary floor, so that floor sweepings may not be swept into the apartment.

In wardrobes the ceilings should be strong and of wood, to take top hanging.

In pantry cabinets, drawers and internal shelving are usually required. Such cabinets, if carried up above table height, are best constructed with glass fronts.

Sanitary Fitting Casings.—Metal baths, and especially galvanized sheet-iron baths, are usually cased with woodwork. This is, where-ever possible, to be avoided. A far more hygienic way is to have such sanitary fittings quite open on every side for the free circulation of air. Where casing is used the bath is usually fixed in a corner and a skeleton frame and cradling fitted up. The top edge of the bath is then covered with rounded-edged boarding, and the sides and shower enclosure lined with lining boards or panelling.

In the same way spaces under sinks or lavatory basins are sometimes enclosed and fitted with doors.

Sink Tops and Draining Tables, if of wood, are best made in one width of kauri boarding from 1 in. to $1\frac{3}{4}$ in. thick. This timber cleans up well, and is suitable for scrubbing. Such tables require

to be channel-grooved to drain to the sink, the space around the sink to have rounded edges and to be bedded in white or red lead. Where against walls, such tables or sink tops should have wood skirtings, or, better still, tiled lined margins flashed with lead close copper-tacked to the woodwork.

Wooden Wash Troughs are also made of wide kauri boarding supported on framed bearers and legs. The height to top should be from 34 in. to 36 in., the whole in two or more divisions about 20 in. wide at top, 15 in. at bottom, and 16 in. deep; the front sloping inwards, and the divisions being each about 24 in. wide. A suitable thickness of timber is 1½ in., with the divisions and ends housed to front and back, and the bottom screwed on with brass screws. The back and front should project and be through bolted with ⅜-in. galvanized iron rod bolts, and all joints should be set in thick white lead, and water should be kept in troughs continuously.

Shelving.—Machine-dressed shelving is imported in various stock widths, the most common of which is 12-in., there being also 14-in., 16-in., and 18-in. widths. Shelving is usually of white pine, yellow pine, American pine, or kauri, and is fitted up on bearers fixed to walls and supported between on framed wooden cantilever brackets or metal brackets made for the purpose.

Chimney-pieces.—Chimney-pieces, or " mantelpieces," as they are sometimes called, are now usually made of wood, to frame or to enrich the space above the fire-place. These are usually purchased ready made, and fixed in position. A better method is to design them specially to suit each apartment, and to finish and decorate them in harmony with the other woodwork of the apartment in which they are placed.

A wooden chimney-piece is shown in the interior (Chapter VIII., Plate XL.)

Grilles.—Wood ornamental grilles are used as overhead infillings to interior lintelled or arched openings, and are of a great variation of design. These, too, should be designed and decorated in

harmony with the surrounding work. Such a grille forms part of the interior design illustrated in Chapter VIII., Plate XL., and acts as an overhead screen between the main apartment and angle bow window.

CHAPTER XVI.

ROOF COVERINGS.

General Requirements of Roof Coverings.—The all-round question of roof coverings requires careful consideration in architectural work.

There is, first of all, the important practical consideration of keeping out the weather and protecting the building, as well as may be, not only from the rain, but also from heat and the changes of temperature.

The ideal covering is the one that secures for the building a reasonable uniformity of inside temperature, not violently affected either by heat or cold.

The Æsthetic.—Whilst aiming at these desirable ends the æsthetic appearance of a roof covering should not be forgotten, and this will be affected by texture, color, and form.

The almost invariable decision among English-speaking peoples is in favor of some form of sloping roof, the "flat," though having much to recommend it, being an Eastern form that is adopted but rarely in our midst.

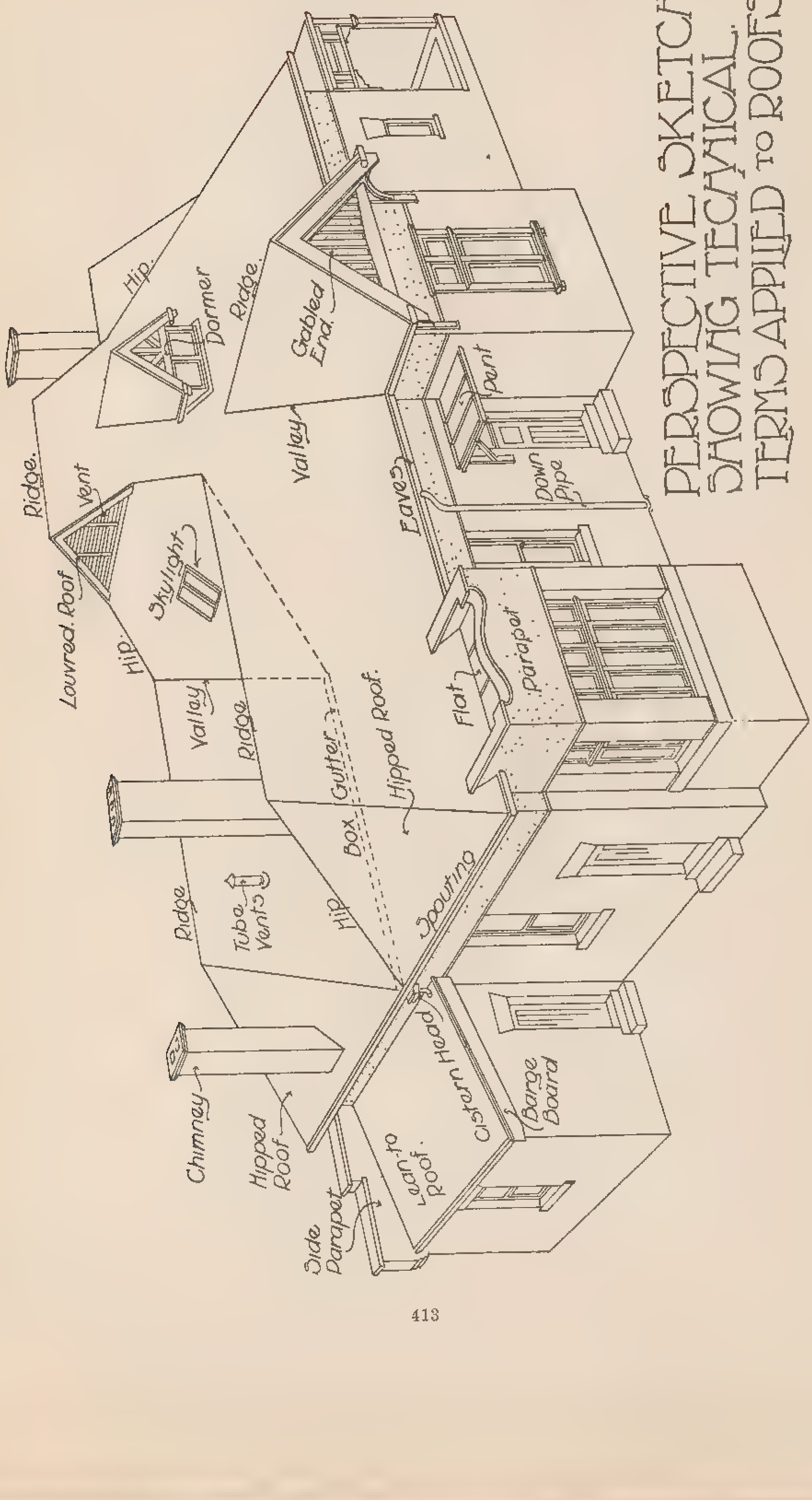
Pitch or Slope.—The pitch or angle of slope of a roof has to be decided consequent upon position, whether specially exposed to heavy rains or not, and upon the character and capabilities of the covering adopted. For instance, a galvanized iron roof, having but very few joints, and those tightly fastened down, may (should the question of internal heat not be a vital one) be placed at a very low pitch, whereas wood shingles, being uneven, small, and

many-jointed, require a very steep slope to render them effective. In a varying degree this is true of tiles and slates, while the danger of the asphalt flat is that it is specially liable to crack from too great an exposed expanse of somewhat rigid surface in contact with the outside elements, and no buffer air space lies between the outside air and the apartments.

Names of Coverings.—The roof coverings in general use are tiles, slates, galvanized corrugated iron, and wood shingles, and for large flat roofs felt or asphalt; for small flats, galvanized sheet iron. In addition, certain specially manufactured materials, such as continuous felts or papers, asbestos tiles, metal tiles, &c., are used for certain classes of buildings.

Roof Diagram.—From a careful study of Plate LXXXV., which is a perspective sketch showing technical terms applied to roofs, an idea may be obtained of the leading parts of a roof and the technical terms adopted when speaking of roof coverings. This diagram has been specially drawn so as to allow of the leading general lines being clearly understood. Here we see how a roof may be set up, the application of such terms as the following being clearly shown, viz.:—Eaves—ridge—valley—gable-ended roof—hipped roof—lean-to roof, with such subsidiary terms as flat—pent—skylight—dormer—louvred vent—tube vent—chimney—parapet; together with such attached parts as eaves spouting—cistern head—rain-water down pipe—box gutter—barge board, &c.; these terms being of common application and use in all general roofing. Later on it will be shown how these various parts are constructed and finished.

Corrugated Iron Roofs.—The indispensable necessity of obtaining the full benefit of the roof covering as a catchment area for rain water for domestic purposes has brought into being the large percentage of galvanized corrugated iron roofs that are seen throughout the country. This material has the advantage of lightness, watertightness, and cheapness. Easily handled and fixed,



PERSPECTIVE SKETCH SHOWING TECHNICAL TERMS APPLIED TO ROOFS

it offers at once the soundest and cheapest all-round roof covering obtainable for common use.

Æsthetic Aspect of Iron Roof Covering.—In æsthetic qualities, however, it is seriously defective, and in spite of red and white coloring, with which it is sometimes coated, its "thin" appearance greatly detracts from its effect as a satisfactory roof material for buildings of any architectural pretensions.

Non-Resistance.—It is also defective in power to resist changes of temperature, heat and cold both passing readily through it.

Imported Iron.—Galvanized corrugated iron for general roofing purposes is imported in various gauges and sizes. The most commonly used is that showing 3-in. corrugations in sheets 5, 6, 7, 8, 9, 10 ft. in length, with a width of about 27 in., the gauge (*i.e.*, thickness) being 26 or 24 Birmingham wire gauge (B.W.G.)

How to Lay Roof Iron.—This iron should be fitted with two-corrugation side lap, and from 5 to 8-in. end lap, according to the flatness of pitch and exposure of aspect.

Corrugated iron is secured either by special spring-headed nails or by screws and washers made for the purpose. These fixings are pierced through each alternate corrugation to underside wood battenings or purlins, spaced about 30 in. apart centres. (See Plate LXXXVI., fig. 1.)

Where wider spans than this exist the sheets are best rivetted together.

One rigid rule should be stringently enforced with all galvanized roof iron work. Every nail or iron fitment used in connection with it should be galvanized.

In Hurricane Zones.—In districts subject to hurricanes or excessively high winds roof iron should be further secured with long, tough wood battens laid along horizontal joints outside and bolted right through the roof timbers to the inside. This is to prevent individual sheets being torn off.

Galvanized Roofing Tables.—

APPROXIMATE NUMBER OF SHEETS OF ORDINARY 26 AND 24 B.W.G. GALVANIZED CORRUGATED IRON TO A CASE (WEIGHING ABOUT 10 CWT.)

Length of Sheet.	26 B.W.G.	24 B.W.G.
5	115	83
6	96	70
7	82	60
8	72	52
9	64	47
10	57	42

COVERING CAPACITY PER SQUARE (100 FT. SUPER) OF A TON OF THE ABOVE IRON.

26 B.W.G.,	Single Lap	About 22 squares.
,,	Lap and Half	,, 20 ,,
,,	Double Lap	,, 19 ,,
24 B.W.G.,	Single Lap	,, 16 ,,
,,	Double Lap	,, 14 ,,

Nails.—If spring-headed nails be used, one packet (100 nails) is usually allowed per square.

SHINGLING.—Shingling consists in covering a roof with small wood slabs called "shingles"; these are either split or sawn.

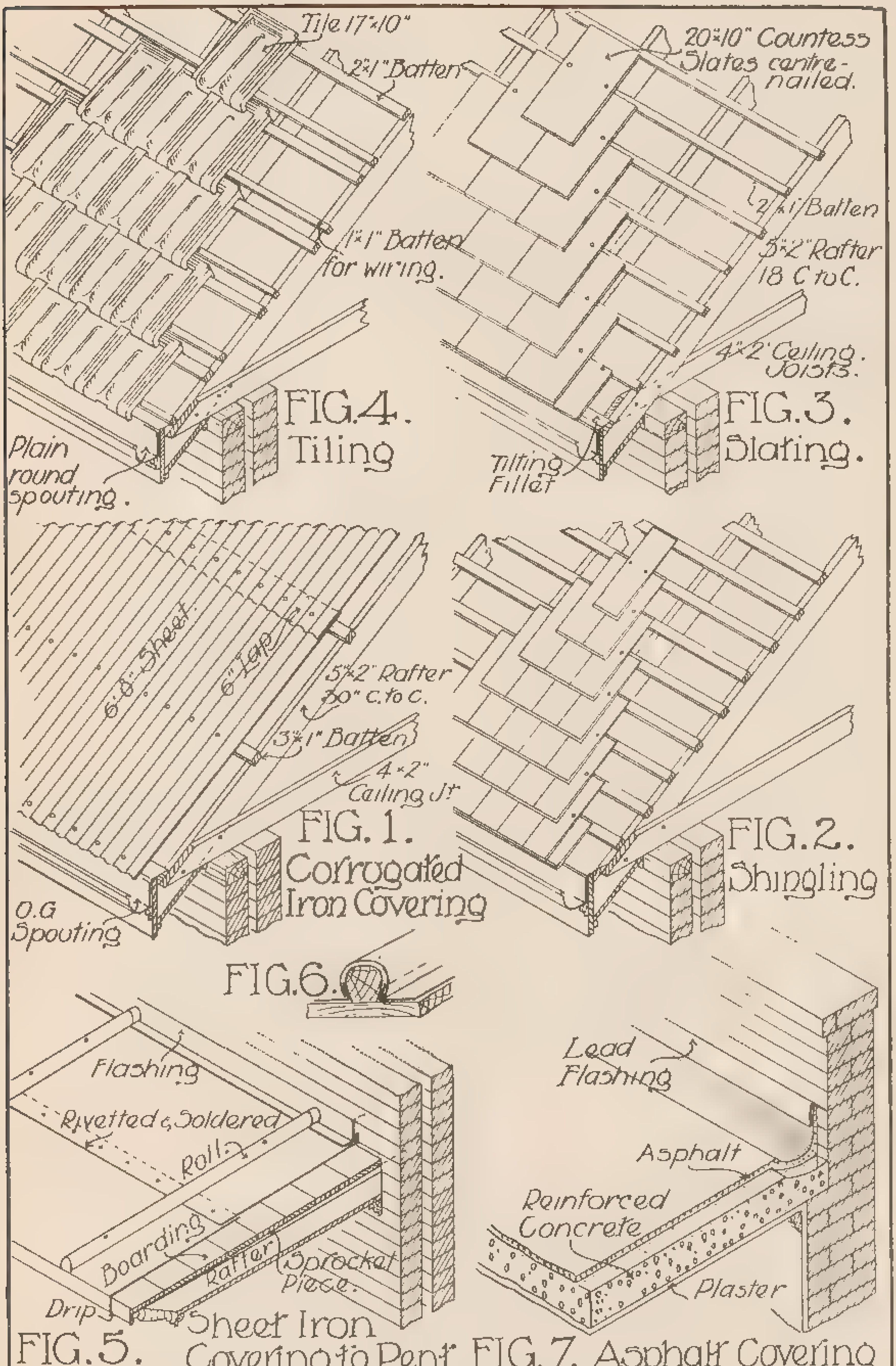
For shingling certain kinds of splitting gums are used, such as blue gum, Tasmanian peppermint gum (this being one of the most lasting); sawn jarrah, and sawn, feather-edged Californian red pine are also used.

To test peppermint gum, dry and place in water, when the wood immediately sinks.

Shingles are laid and left plain or saturated with oil, treated with creosote or special-made stains. Shingles should only be laid upon steeply pitched roofs.

The general use of this material is much restricted on account of the danger from fire, such a material being prohibited within city areas. It is, however, very picturesque, and, after weathering, looks particularly well among rural scenery.

Size.—Shingles differ in size, those of splitting gum being



ROOF COVERINGS.

generally about 15 in. by $4\frac{1}{2}$ in., though they are sometimes used much longer and wider. Imported redwood shingles are generally about $15\frac{1}{2}$ in. in length, and vary from 4 in. to 12 in. in width. These are cut to feather edge.

Lap and Laying.—The lap in shingling varies with the material used and the angle or pitch of roof slope. Split shingles require more cover, because they are less in surface than sawn shingles.

For split shingling 3-in. by 1-in. hardwood battens are generally used, and shingles set to from $4\frac{1}{2}$ in. to 6 in. lap and nailed each with two ordinary wire nails, the shaping being done with a tomahawk.

Shingles are fixed similarly to slates (see Plate LXXXVI., fig. 2). Sawn shingles may all be gauged to one even width and the whole laid to break joints in the same way as slating. This is, however, but seldom done, the ordinary method being to have the material of varying widths, and to make broken joints as the work proceeds.

Hip and Ridge Covers.—Shingles are generally roughly cut at hips and covered with close-nailed boarding, the hips being close-covered in the same way.

With large sawn shingles the hips may be cut true to mitre and underflashed with zinc soakers in the same way as slating. (Plate LXXXVIII., fig. 3.)

Wall Shingling.—Shingling is also used for covering roof gables, lining outside surfaces of projecting bays, and for other similar purposes. Gum shingles, if left virgin, may be depended upon to weather in soft greys, or jarrah shingles may be kept to their red color by being constantly well oiled.

Slate Roofing.—*Qualities and Sizes.*—The roofing slates used in Australia are mostly imported from Wales, America, or the Continent of Europe, only a limited quantity of local slates being used.

The general commercial sizes and colors of the various kinds may be set down as follows : —

Welsh.—Pink, blue, and purple.	*American.*—Blue and green.
24 by 12	20 by 10
22 by 12	24 by 12.
22 by 11	*Continental.*—Blue, pink, and green.
20 by 12.	Chiefly 20 by 10.
Chiefly 20 by 10, Countesses.	
18 by 10	*Australian.*—24 by 12
18 by 9	to
16 by 8.	16 by 8.

An old practice is to describe by name the size of slates, such as duchesses, 24 in. by 12 in.; countesses, 20 in. by 10 in.; ladies, 14 in. by 12 in.; doubles, 12 in. by 8 in., &c., but as slates of the same name vary in different localities, it is better to describe a slate by size only, and add color and locality of quarry.

Quality of Good Slates.—Roofing slates should be compact in texture, practically non-absorbent, and capable of giving forth a ringing sound when struck. They should be hard and rough, not greasy, those giving a sharp fracture when cut being the best. These qualities, together with uniformity, permanence of color, and freedom from bars—*i.e.*, disfiguring cross lines being the best.

Sorting, Dressing, and Grading.—The first process in dealing with roof slates is sorting, dressing, and grading. The slates are picked over, any rough edges squared off, and two holes for nailing punched, either by machine or by hand, through each slate. The slates are then graded into thicknesses. This is accomplished by grading the slates into groups or classes, such as thick, medium, and thin. This ensures flat laying in the final work, equal thickness slates being laid in groups together—viz., thick at bottom (near eaves), medium in centre, and thin at top (near ridges).

Nails.—Two wide, flat-headed slating nails to each slate are required. These are either $1\frac{1}{8}$ in. or $1\frac{1}{2}$ in. in length, and of non-rusting material, such as copper, zinc, compo., or galvanized steel.

For diagram showing how slates are laid see Plate LXXXVI., fig. 3.

Actual Laying.—Slates are laid in horizontal courses from the eaves upwards, with close-butting side joints in every case, each

slate centrally bonding and breaking joint, one directly above the other, the top slate leaving a certain portion of the slate below revealed, which is called the "gauge."

The lap is the all-important point in slating. This is the actual cover all the joints have when the roofing is completed, and should be from $2\frac{1}{2}$ to 3 inches.

In preparing the roof for slating 2-in. by 1-in. long deal battens are required, fixed in parallel rows according to size of slate and gauge. The slates are secured to these by means of two slating nails passing through each slate.

The rule is to commence slating from the bottom by a double course, slightly projecting into spouting or gutter. This course should be set up above the general line by a tilting fillet, so as to shoot the water clear off. From the eaves the laying is carried on upwards, course upon course, to finish at the ridging with a short course, the lap being sustained throughout.

Hips.—Hips are either mitred—*i.e.*, only slate showing—or plain and covered with galvanized iron capping, or they may be covered with tile hipping.

Mitred hips are those in which the slates are cut close and fair to the mitre of the hip; these do not require capping. For mitreing, hip boarding from 6 in. to 9 in. is laid, upon which thin zinc soakers are secured. The soakers cover the actual mitre, and are interposed between the slates, so as to throw the water to the outside.

In mitred hips the slates require to be in pieces as large as possible, each piece being screwed with galvanized iron screws.

Ordinary hips are roughly cut and afterwards covered with hipping, generally of galvanized sheet iron, the same as the ridging.

Valleys.—The internal angles or valleys are formed by fair cutting to a true-line the intersecting slopes, leaving space between for water to pass down the valley guttering. (See Plate LXXXVII., fig. 1.)

Rendering.—In very exposed, wet positions slating may be inside

rendered in hair mortar, compounded of four parts of sand to one part of lime, with a proportion of long cowhair intermixed.. From the inside the top and bottom joints may be pointed up after the slates are laid, or each course may be headed in mortar, course by course, as the work proceeds.

Circular and Special Work.—In circular-ended roofs, round turret tops, &c., the slates require to be specially small and carefully cut. This class of work must be laid on close boarding, the smaller slates being screwed into position.

Bands or patterns of varying colored or shaped slates are sometimes laid into roof coverings, but this is a mannerism not to be recommended, a plain, simple roof of good color, with mitred hips, giving the best possible results.

Cleaning Down.—Should slating become stained with mortar, &c., clean down with dilute muriatic acid and full quantity of clean water.

Measurement.—Roof slating is measured by the square of 100 ft. super—*i.e.*, a square of 10 ft. by 10 ft. By setting out to scale upon paper a surface of this size, with slates and gauge required, the number of slates per square may be readily estimated, also the quantity of nails, two being allowed to each slate.

Slates are sold at per thousand.

Tile Roofing.—From time immemorial tiles have been used as a roof covering, and if well made this branch of ceramic manufacture supplies one of the most practical and permanent roof coverings known.

Tiles.—Roofing tiles are made of terra-cotta, either plain or of shape so as to fit one into the other in laying.

The tile in most general use in Australia is of the Marseilles pattern, either imported from Marseilles or locally manufactured. This is a shaped and interlocking tile, averaging about 16¾ in. by 10 in., with a weight of about 5½ lbs., which, upon being fully saturated with water, may increase to about 6¼ lbs.

They have the advantage of being self-ventilating, which is at once apparent from the inside of a roof, the space being lighted through the interstices of the covering, whereas in all other roof coverings this ventilating quality is absent.

Tiles may be excessive in weight, especially when charged with moisture, and the fact that they are more absorbent than other roofing material requires to be taken into consideration in building the roof timbers; though their absorbent character may be useful in reducing temperature by rapid evaporation in summer weather after light showers.

Flat Tiles.—English tiles are mostly of the flat pattern, 14 in. by 6 in. or 12 in. by 6 in., with two hanging clips or holes for oak peg fixings. These make a close and even-surfaced covering compared with which the Marseilles pattern looks heavy, and, upon one-story buildings especially, clumsy. There is, however, no ventilating in them.

Quality of Good Tiles.—Tiles for roof covering should be sound (true to ring), not distorted, dense in structure, reasonably non-absorbent, and of good and uniform color and not over-heavy.

Tile Accessories.—For use in conjunction with tiles specially-made terra-cotta ridging, plain and ornamental cresting, and interlocking hipping is made locally, as also molded, shaped, and ornamental finials, &c.; these are used for the completion of parts of the roof not coverable by the ordinary tiles.

Tile Cutting.—Tiles may be chisel cut and rubbed to shapes as required for valleys, hips, mitres, &c.

Actual Laying.—Marseilles pattern tiles are easily laid, each tile close up side by side and to straight horizontal lines. (Plate LXXXVI., fig. 4.)

The gauge is fixed by the form of the tile, one tile locking into the other.

Two deal battens are required, one 2 in. by 1 in. and one 1 in. by 1 in. Upon these the tiles rest, being wired on with wire

passing through a pierced eye made in the back of the tile. For this purpose 18-gauge copper or galvanized steel wire is used.

Should the roof be boarded the tiles may be wired through holes bored in the covering, or staples may be driven into the boarding to take the wire.

Valleys.—The valleys of tiled roofs are laid with sheet metal similarly to those of slated roofs.

Laying Special Parts.—Hips are covered with terra-cotta hipping, ridges with plain or ornamental cresting. These special parts are bedded in hair mortar made of four parts of sand to one of lime mixed with cowhair.

Pointing.—The outer joints of hips, ridges, overhanging gables, &c., are pointed up in colored mortar compounded of Portland cement and sand, three to one, with Venetian red or other coloring matter added.

Measurement.—Roofing contracts are generally taken at per square, tiles of the Marseilles pattern requiring about 113 tiles to the square, with $1\frac{1}{2}$ lbs. of wire.

Hanging Tiles.—For lining external half-timbering gables, &c., flat hanging tiles are sometimes employed. These have either plain, square ends, or ends ornamented to various cut-out shapes. Hanging tiles are generally holed, and may be secured with slating nails to battens, or hung with wood pegs. Clips are sometimes formed on the ends of the actual tiles for hanging purposes, and wire used. Hanging tiles are set to gauge in the same way as slating.

Cleaning Down.—Clean down tiling at completion with dilute muriatic acid and pure water.

Plumbers' Work in Roof Coverings.—Plumbers' work forms an important part of roofing of whatever kind, and the careful execution of this portion of the work is of the highest importance, for upon it the weathertightness of the smaller parts depends. It is not sufficient to have a good general roof covering; the accessory work must be well done.

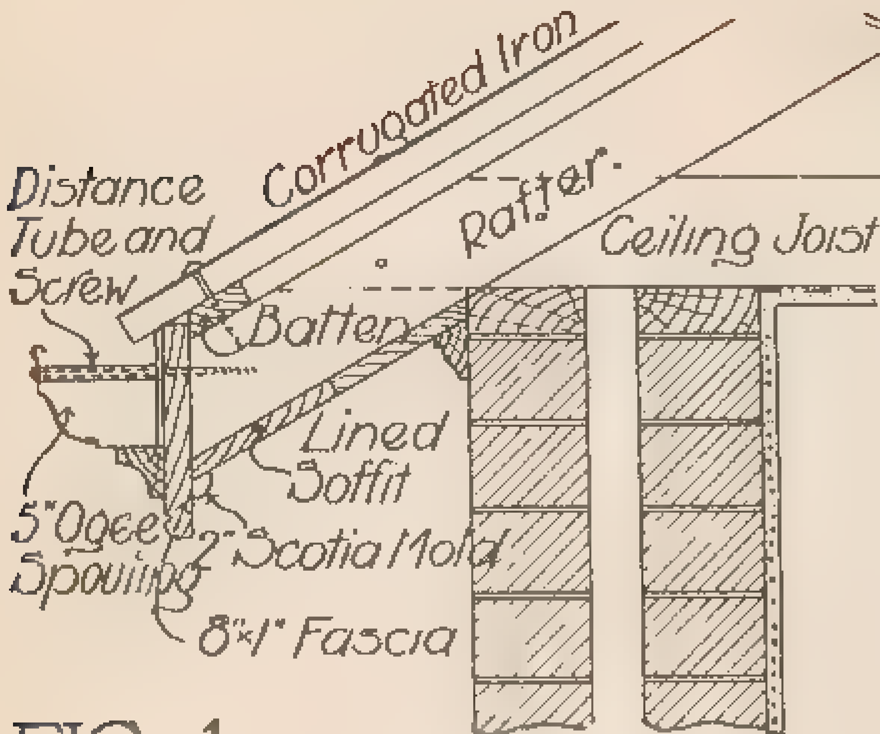


FIG. 1.
Spouting and Eaves to Corrugated Iron Roof.

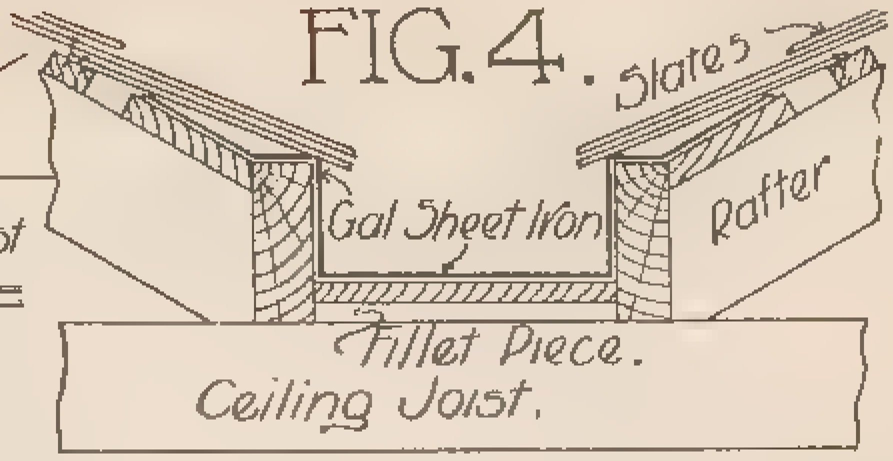


FIG. 4.
Box Gutter between two roofs

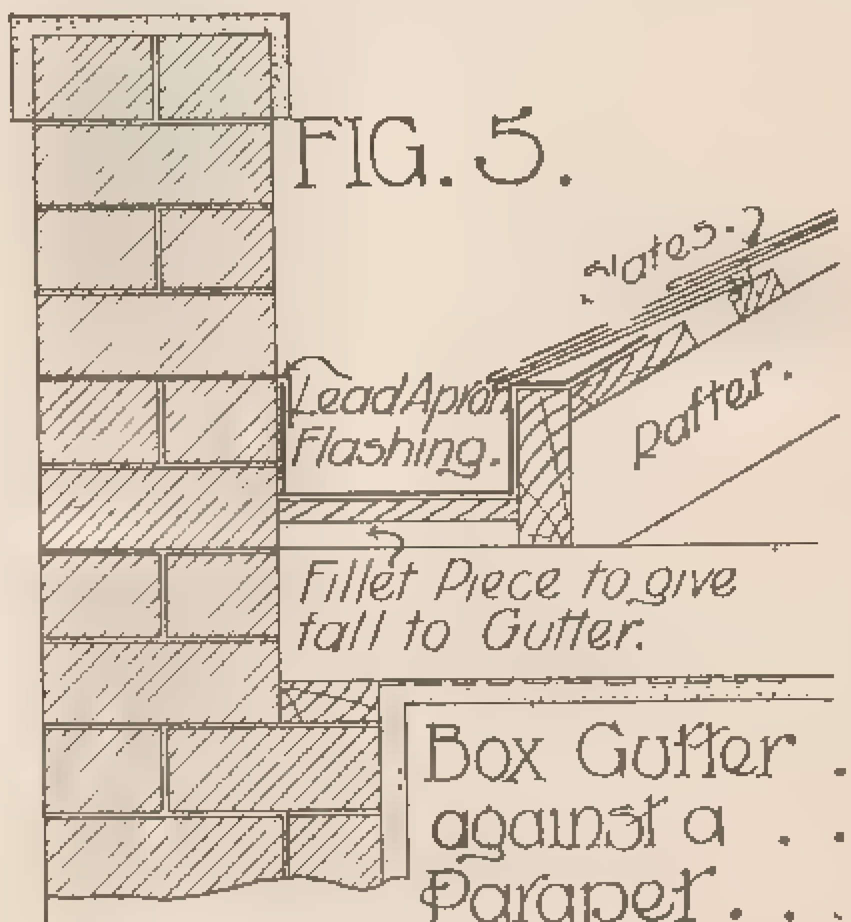


FIG. 5.
Box Gutter against a Parapet...

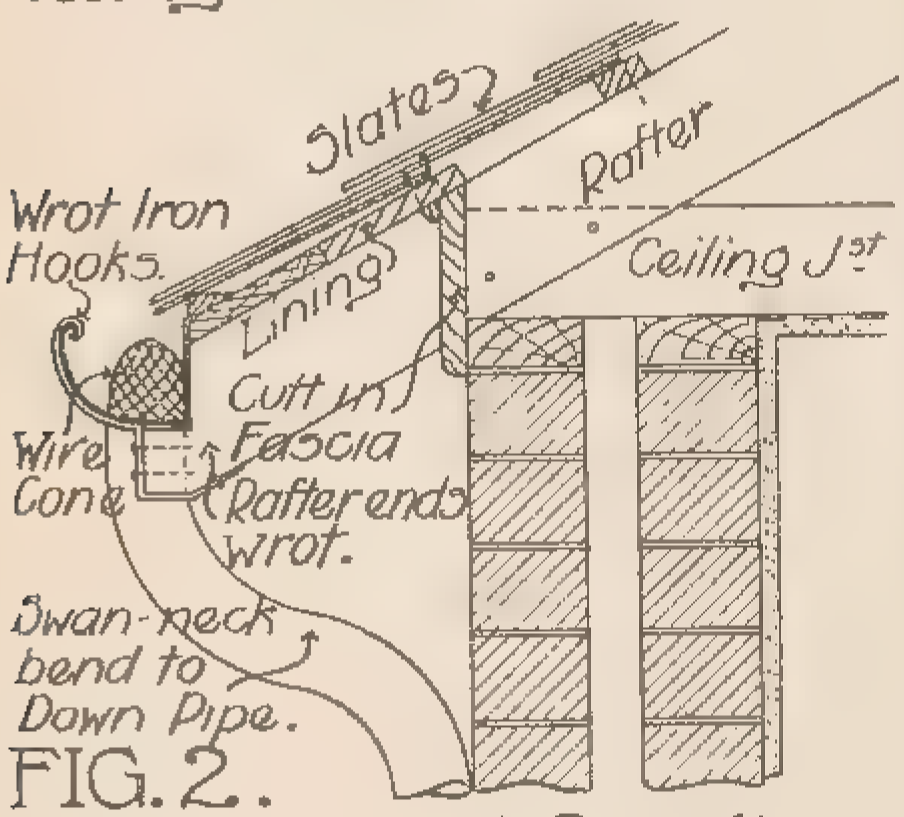


FIG. 2.
Plain rounded Spouting to open eaves.

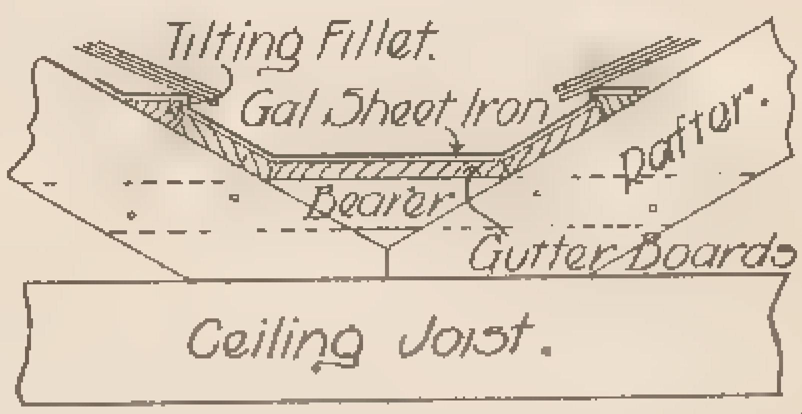


FIG. 6. Tapering Internal Gutter between two roofs.

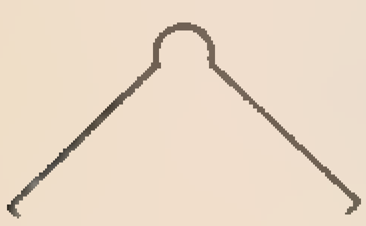


FIG. 7. Section thro. Ordinary Iron Ridging

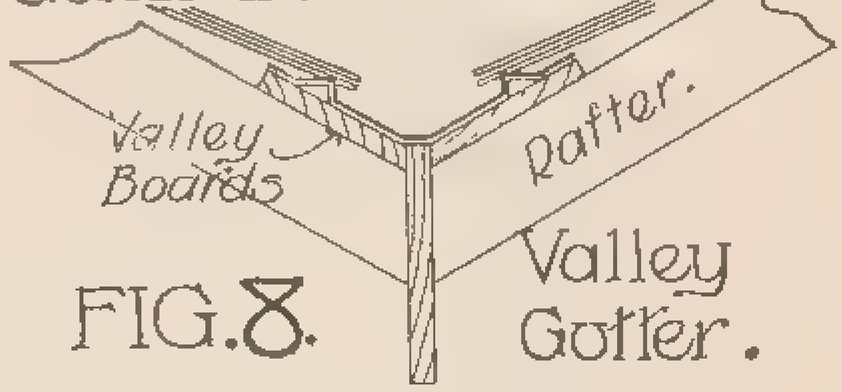


FIG. 8. Valley Gutter.

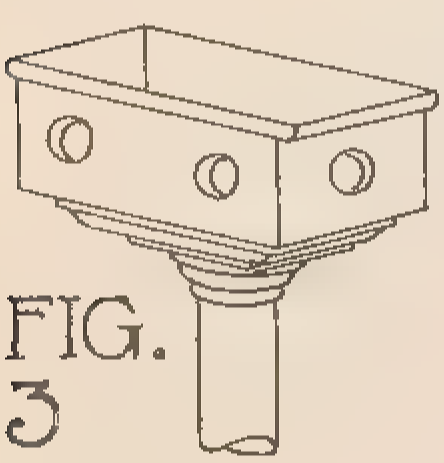


FIG. 3 Cistern R.W. Head.

DETAILS OF METAL WORK TO ROOFS...

Galvanized Sheet Iron Work.—Sheet-metal work enters largely into the average job of roofing, the commonest material used being galvanized sheet-iron for ridges, hips, valleys, spoutings, and down pipes. These are made up for the most part in manufacturing plumbers' shops, and may be purchased as stock articles at so much per foot lineal.

Gutters are generally made upon the works, as they differ with each job.

All galvanized iron work of this kind should be made of special flat iron of some well-known manufacturer's brand. The thickness gauges are from 26 for common, 24 for ordinary, and 22 or 20 for special work.

All bending should be done in such way as to avoid as much as possible damaging the galvanized surface of the iron, and where in the heavy irons this may take place the scaling should be touched over and covered with solder.

Various devices are employed to stiffen iron. It it well known that sheet iron, which in the sheet may be very limp, gains vastly in rigidity when worked up. This is the reason for corrugating. In addition to ordinary bending or shaping, the edges of sheet metal may be further strengthened by turning or welting, or by the in-running of stiffening wire.

In fitting together, good length laps should be given, say about 4 in. in spouting and down pipes, 6 in. in ridging, hips, and valleys, and 7 in. or 8 in. in gutters. Where possible these laps to be double rivetted and double soldered.

Eaves Spouting.—The spouting in most common use is known as O.G. spouting (Plate LXXXVII., fig. 1), the stock sizes of which are—3-in., 4 in., 4½-in., 5-in., and 6-in., in 6-ft. lengths. This is fixed with long galvanized iron screws, pierced through near the top, and inserted into the wood fascia or rafter beyond. These screws are encircled with round, bent pieces of sheet iron called "distance tubes," to keep the back and front of spouting apart when screw is tightened up. These are fixed about every 36 in. apart.

In actual practice screws often draw out, owing to excessive dryness of the wood. The spouting is, therefore, better further strengthened by straps of galvanized hoop iron rivetted and soldered on to the front of the spouting, and brought over or under and nailed to the woodwork.

Plain round spouting (Plate LXXXVII., fig. 2) may be made in heavy gauge iron, and kept in position with wrought-iron eave hooks, as shown in the figure.

Cast-iron molded spouting is now used to a very limited degree. Where employed it should be well painted periodically with oxide of iron paint.

Spouting requires to be set to slight falls towards down pipes, the runs to which should not, as a general rule, total more than 40 ft. lineal of spouting.

Down Pipes.—Down pipes are used to convey the rain water from spoutings or gutters to the ground, whence it is carried off by surface channels or underground pipe drains. This piping is made of sheet iron, and is stocked in a similar way to spouting; the stock sizes being 2-in., 2½-in., 3-in., 3½-in., and 4-in., 26 and 24 gauge galvanized plain iron being mostly used. For special work, and especially for the lengths near the ground that may be subject to knocks, the gauge is best increased to the 20-gauge rivetted quality.

Down piping usually requires angles, shoes, and elbows to render it complete; these are usually purchasable from stock, or made by the plumber by cutting, fitting, and soldering common piping. The best work, however, is done with special curved bends, which are now manufactured for all general purposes. Down pipes are secured to brick walls with galvanized wrought iron, half-round wall hooks driven in to joints of brickwork to clip pipe; where attached to weatherboard sheet metal clips are soldered on. For important permanent buildings square cast-iron down piping is used, having cast on lug connections. Such piping may be set in a chase in the outside brickwork flush with wall facings.

Down Pipe Strainers.—Strainers of galvanized wire worked to a conical shape are fixed to the top ingoing of down pipes to prevent choking by leaves or bird-nest building.

Cistern Heads.—At gutter outlets, or wherever there is an excessive outgoing of rain water, such as at the junction of two down pipes, the water may be collected into a cistern head (Plate LXXXVII., fig. 3). These are made in various stock sizes and shapes out of sheet metal, or may be made to detail. In old English work the rain water down pipe heads were often made a special feature, and some pleasing examples in lead are to be found among the old work.

Gutters.—In roof design internal gutters should be as much avoided as possible, because, owing to their comparative inaccessibility and liability to choke upon sudden emergency (however well constructed they may be), they are a common source of danger in the wet seasons.

When the style of architecture requires parapets, gutters have of course to be arranged, as also when roof slopes meet in the internal parts of wide area roofs.

These gutters are best formed in the "box" or parallel-sided manner. If the ordinary tapering gutter be substituted it has the serious disadvantage of having to spread over an ever-widening area of the roof, increasing with the length of the run, thus exposing wide surfaces of metal to the variable action of the temperature.

In Australia lead should be avoided as a gutter lining material, as the great changes of temperature render it specially liable to creep and crack. The better material is galvanized sheet iron of heavy gauge, carefully bent, rivetted, and soldered at the junction of sheets and left as free as possible (unnailed).

Gutters require a fall of about 1½ in. in every 10 ft., and should be kept free from falling leaves or *débris*, or from snow upon the high or south lands where snow prevails.

Gutters of various kinds are shown on Plate LXXXVII.

Box Gutters.—Fig. 4 illustrates a section through a box gutter—*i.e.*, one with parallel sides. These sides must be kept well up, as all the fall is made in the bottom of the gutter. The depth of gutter at outfall should not be less than 4 in. The size of such a gutter will depend upon its length and the catchment area of roof it serves.

This figure shows the sheet-iron lining bent, shaped, and worked over the gutter sides on to the boarding, well under roof covering.

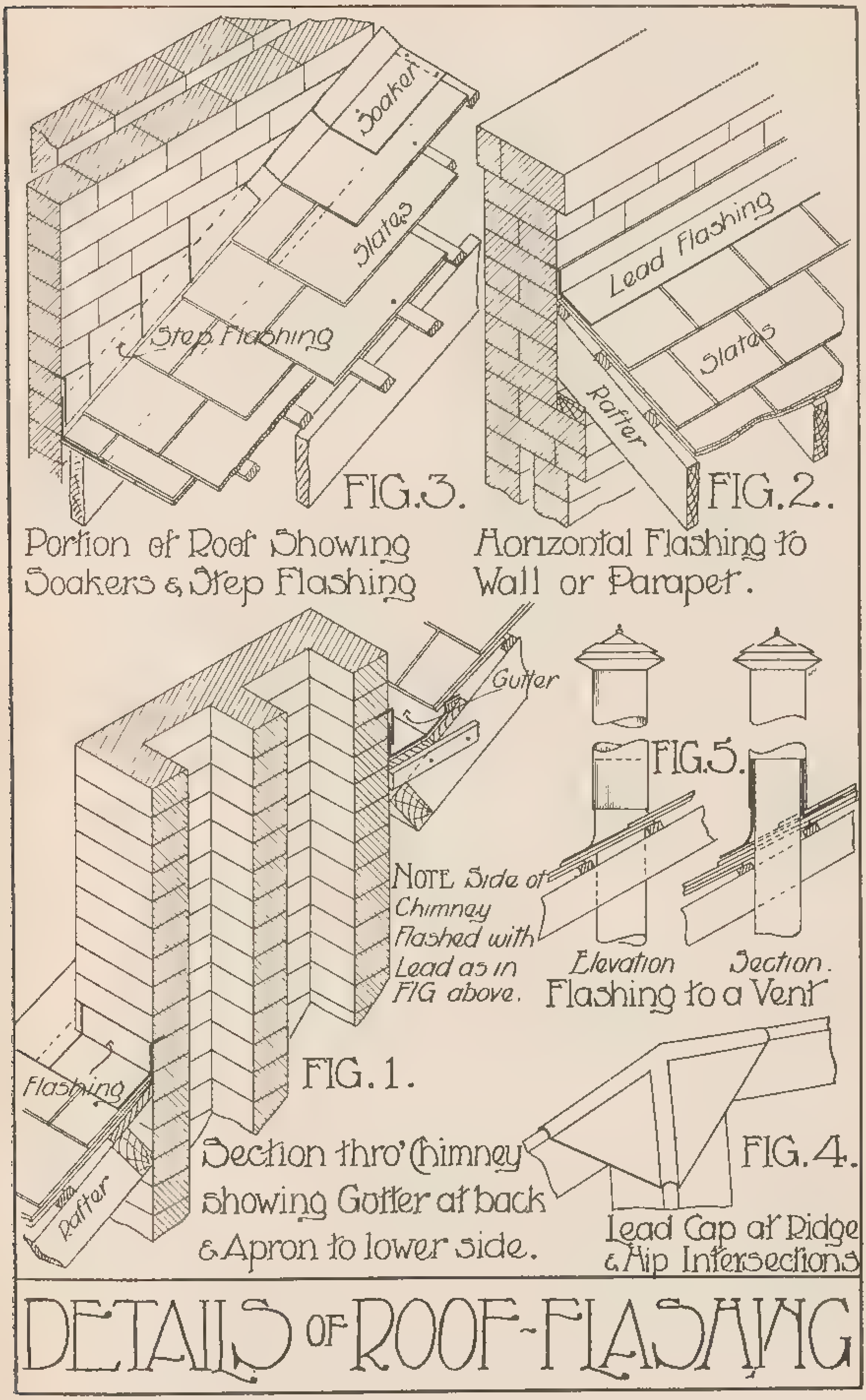
Fig. 5 shows a box gutter next a parapet wall. Here the same general principle prevails, save that on the left side the iron lining upstands against the brick wall, where it is lead apron flashed over.

Tapering Gutters.—Fig. 6 shows a section through an ordinary tapering gutter between the two internal slopes of a roof. In this type of gutter a certain width at outlet is allowed for and a given fall determined. The gutter in working out widens in the ratio of these, and may be very wide indeed at its head, especially between low-pitched roofs. The bottom is supported on bearers nailed to sides of rafters at varying heights, the gutter being formed of close boarding and side tilting fillets, over which the sheet metal is dressed.

Valley Gutters are parallel sided, and may be constructed as shown in fig. 8. Valley gutters may also be formed of stock galvanized sheet-iron ridge capping, reversed.

Chimney Gutters.—Where a roof slope meets a right angle upstanding surface such as a chimney stack (Plate LXXXVIII., fig. 1), a gutter is usually formed as shown. This portion against which the gutter abuts is called the back of the chimney. As these gutters are comparatively small, they may be of lead throughout, with fall from centre of stack two ways, the roof covering being brought almost close up against the wall.

Metal Flats.—Occasionally small portions of roofs are laid in as "flats," such as roofs of bays and small projections, apart from the roof proper, also shelter pents overhanging outside doors.


Soaker
Slates
Step Flashing
FIG.3.
Portion of Roof Showing Soakers & Step Flashing
Lead Flashing
Slates
Rafter
FIG.2.
Horizontal Flashing to Wall or Parapet.
Gutter
NOTE Side of Chimney Flashed with Lead as in FIG above.
Flashing
Rafter
FIG.1.
Section thro' Chimney showing Gutter at back & Apron to lower side.
FIG.5.
Elevation
Section.
Flashing to a Vent
FIG.4.
Lead Cap at Ridge & Hip Intersections
DETAILS OF ROOF-FLASHING

This form of roof covering is not desirable for the whole area of a roof, though it offers a workable covering for small areas.

Metal flats are made of sheet metal, either in copper, zinc, sheet iron, or lead, the latter only being recommended in a cold, equable district. For all-round purposes galvanized sheet iron may be used. The same rules that apply to the construction of sheet metal gutters should here be observed—*i.e.*, that the sheets should not be over large, and that they should be arranged together and worked to shape so as to be left as free as possible for expansion and contraction under the changes of temperature.

Plate LXXXVI., fig. 5, shows a pent roof, such as is sometimes used as a shelter over an external doorway, in galvanized sheet iron. The woodwork is arranged with slight fall and on close boarding. Rolls (fig. 6) are arranged at intervals to suit the size of sheet metal used. These are secured to the boarding in the direction of the fall and at right angles to eaves.

The iron is first turned up against the wall, upstanding at the side of the roll, and well lapped in the direction of its length. This lap may be rivetted and soldered if desired.

The rolls and upstanding edges of sheets are covered with a roll piece cover, rounded on top, so bent as to spring over and clinch tightly in position, being secured on top with galvanized screws and lead washers.

Small spouting may be fixed at eaves, or "dripping eaves" may be formed by securing a thin wood slip along the edge, around which the metal is worked and turned fair around on the underside.

The upstanding iron next wall is overflashed with sheet lead in the usual way.

Flats are sometimes arranged with falls in two or more directions, when the rolls have to be arranged accordingly, sometimes at right angles.

The lining of vertical sides of roof turrets and similar work may be carried out in the same way by plain areas of sheet metal, having the joints covered with metal rolls.

Metal Ridges and Hips. -For all general purposes galvanized sheet iron is used for ridge and hip covering in roofs, the exception being in tiled roofs, where terra-cotta is employed.

Stock ridging is bent up as Plate LXXXVII., fig. 7, and is stocked in lengths, the widths being 12 in., 14 in., 15 in., 16 in., and 18 in. These are end lapped and secured in position with galvanized screw or spring-head nails, either near the outside edges or through the top. It may also be strengthened by stout galvanized hoop-iron pass-over clips secured to woodwork. In very exposed positions, when used on galvanized corrugated iron roofing, the strips of lead may be soldered along the underside edges of the ridging and dressed close into corrugations, thus preventing indriving of rain.

Flashing consists of sheet metal cut and dressed so as to render watertight the junction of roof coverings with walls, the cutting around tube vents, the meeting of iron hips and ridges, and any other parts of a roof covering requiring to be overdressed.

Sheet Lead is the material mostly employed, as it is both malleable and non-corrosive; it requires, however, in all cases to be left free for expansion, and must be secured by such means as render this freedom possible.

For all ordinary work 4 lbs. or 5 lbs. (per foot super) milled lead is employed.

Sheet Iron and Zinc.—Galvanized sheet iron or zinc may also be used for certain classes of work. These materials, however, lack the quality of lead.

Horizontal Cover Flashings.—A direct cover flashing is shown in Plate LXXXVIII., fig. 2. This is at the junction of a slate lean-to roof, and shows a strip of lead built into the wall and dressed down over the roof covering.

Similar flashing is seen on the lower side of chimney stack (fig. 1).

Stepped Flashing is shown in fig. 3. This type of flashing is used where roof slopes cut against walls. In this figure a slate

roof is shown where pieces of underflashing called "soakers" are inserted under the slates to upstand against the wall. These soakers are overflashed with stepped cover pieces secured to joints of brickwork.

Raking Flashing.—In very flat-pitched lean-to roofs, top courses of brickwork may be built parallel to pitch of covering, and flashing (without steps) built in. This is called "raking flashing." Should the roof, in such a case, be covered with corrugated iron the iron may be flattened out and a right angle bend made to upstand against the wall, overflashed in the usual way.

Junction Caps.—The junction of iron ridges with hips requires to be overflashed with lead. These are called "lead junction caps." See fig. 4.

Flashing around Vents.—Where pipes upstand through ridge coverings they are usually flashed as shown in fig. 5—*i.e.*, by means of a collar-like apron-piece of lead, dressed to upstand around the lower portion of the pipe, over which the upper length of the pipe is made to fit.

Indressing and Finishing.—Where flashings are used on unequal surfaces, such as over Marseilles tiles or corrugated iron, the lead should be neatly and closely dressed into all interstices, and always of full width to afford good cover.

Apron flashings are sometimes built into brick walls as the work proceeds. In the case of stepped flashing this is not possible. The mortar joints require to be raked out, and the lead inserted and secured. This may be done either with wedges formed of small pieces of sheet lead or by galvanized iron wall hooks.

In stone walls, raglets—*i.e.*, joint-like channels—are cut to receive the lead.

All wall joints of flashings require to be stopped in and pointed in cement mortar.

Asphalt Flats.—Plate LXXXVI., fig. 7, illustrates an asphalt-covered flat roof. This material is best laid on concrete in some

such manner as shown in diagram, which shows a reinforced concrete ceiling, forming the roof. This concrete requires to be laid to falls, and with channels so formed as to act as rain water gutters. Very great care has to be taken in this class of work, and experience has shown the value of so arranging the asphalt covering that it is laid as a carpet without adhesion to the concrete. The asphalt should upstand around and against parapets, so as to be left free for expansion, the joint being apron-flashed with lead.

Flat roofs constructed in this way have their value in producing an open usable area upon the top of a building. Great care, however, must be taken in this form of construction. Only the very best material and the highest skilled labor should be employed, otherwise the result of leakages may prove disastrous.

Natural rock asphalts are best, or those with true bituminous body. Ordinary tar asphalt should not be used.

A somewhat cheaper kind of flat is sometimes formed on boarding by laminated layers of continuous felt paper saturated with bitumen paint, upon which asphalt is laid.

Special Manufactured Coverings.—There are placed upon the Australian market from time to time specially manufactured materials, for use as roof coverings other than slate, tiles, and iron. These consist of such materials as continuous felts, saturated papers, &c., laid in strips upon boarding, lapped, and secured with mastics and flat nailing. Rigid asbestic sheets, ornamental stamped sheet metal tiles, and numerous other means of roof covering, are also used.

In addition to the ordinary outside roof covering, certain additional means are employed in high-class work, to make the roof as non-resisting as possible. All roof coverings have some disadvantage as well as advantage, and these traits may, in a degree, be counteracted by undercovering.

To keep out heat the simplest device is to close board the roof

on top of the rafters, which may be covered with non-conducting felt, or felt or non-conducting paper may be laid on wire-netting directly on top of rafters.

Non-conductors are also laid on top of ceilings, such as dry sea-weed, sawdust, or the winnowings from wheat-threshing machines; a small admixture of lime will form the latter into a valuable pugging.

The outside white coating of the actual roof material by non-conducting paints is also of value in hot districts, especially for galvanized iron roofing.

The free passage of air through the roof must also be considered and allowed for, not only to prevent dry rot in the timbering, but also to move the inner air, and to allow of the beneficial influence of wind currents. For this see "Ventilation," Chapter XVII.

CHAPTER XVII.

VENTILATION.

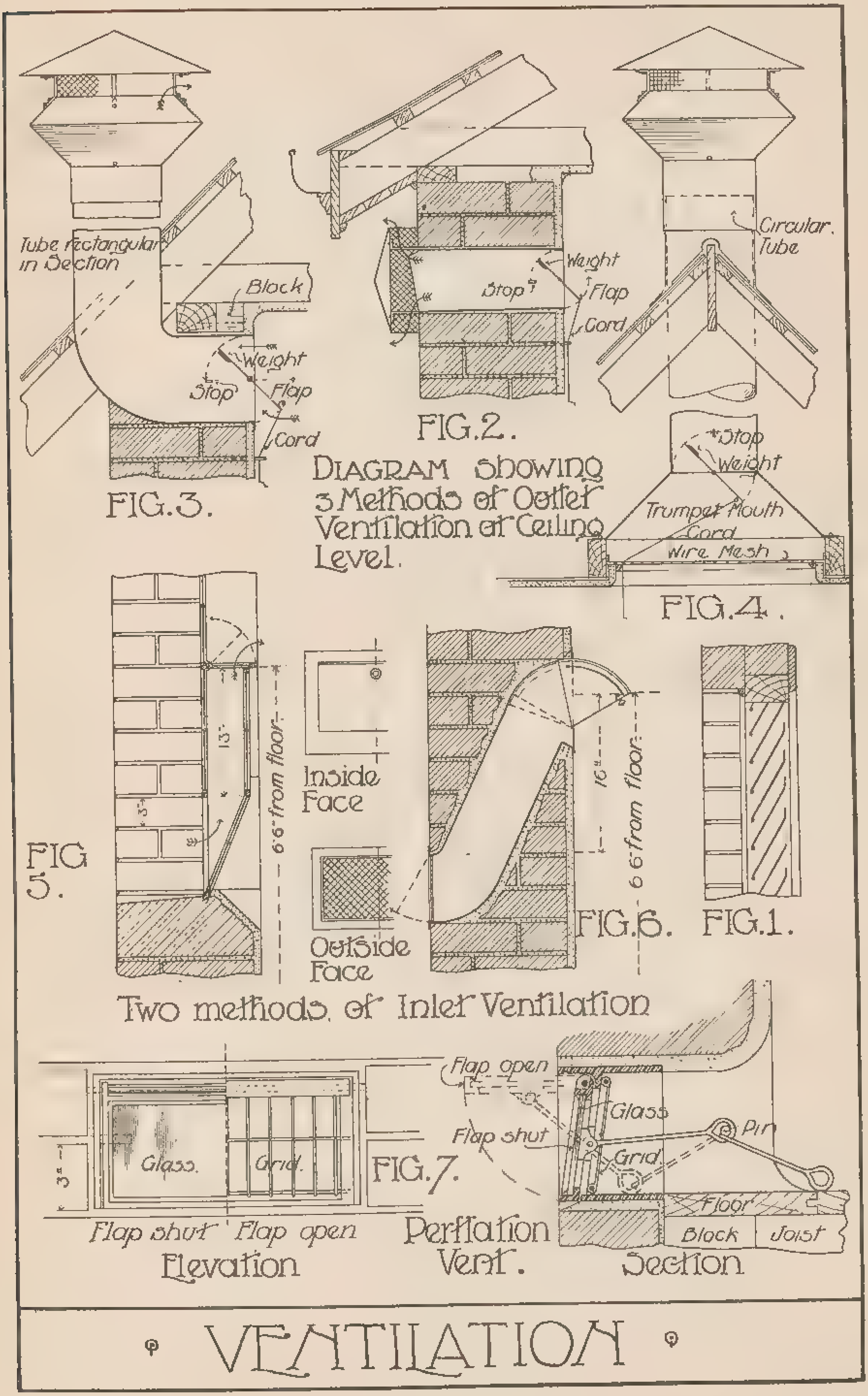
Ventilation is the science of supplying pure air and of carrying off vitiated air from buildings. It also has to do with air supply to structural timbers to prevent dry and wet rot, and also with the various problems of cooling and warming apartment air, so intimately associated with the health of those who use modern buildings.

Ventilation is often surrounded with many difficulties, which find much added complexity when buildings, as in close-packed cities, are surrounded and shut in by other structures.

To obtain a constant but gradual changing of air without draught is the problem of ventilation.

Ventilation of Structures.—*Under Floors.*—All the structural parts of a building should be ventilated, and especially should air be circulated under wooden floors and among roof timbers, as, should the air remain dead, or the timbers be too closely built into walls, either dry or wet rot is certain to set in, and this may destroy the best of timber in a few years.

In ventilating under floors, ornamental, galvanized, cast-iron or terra-cotta ventilators made for the purpose are usually built in flush with the outside surfaces of the walls, at distances of about 8 ft. apart, and holes are left in underfloor dividing walls for the free circulation of air. These vents should be so arranged as to create cross draughts and free-way currents of air, yet so protected


Tube rectangular in Section
Block
Weight
Stop
Flap
Cord
FIG.3.
Weight
Stop
Flap
Cord
FIG.2.
Circular. Tube
DIAGRAM showing 3 Methods of Outlet Ventilation at Ceiling Level.
Stop
Weight
Trumpet Mouth
Cord
Wire Mesh
FIG.4.
13"
6'6" from floor
3"
FIG 5.
Inside Face
Outside Face
16"
6'6" from floor
FIG.6.
FIG.1.
Two methods of Inlet Ventilation
Glass.
Grid.
3"
FIG.7.
Flap open
Flap shut
Glass
Grid
Pin
Floor
Block
Joist
Flap shut
Flap open
Elevation
Perflation Vent.
Section
VENTILATION

at back by galvanized wire as to prevent rats or mice from entering the building.

Face vents are usually made to stock sizes, such as 9-in. by 3-in. or 9-in. by 6-in. In important stone buildings they are usually specially designed and made.

In Roofs.—Closed-in roofs should always be ventilated separately from the apartments below them. Where Marseilles tiles are used, without close boarding under them, this form of covering offers good ventilation. Slates and iron, however, being closer, require to have louvred or cowl vents from the roof space. These should be so arranged as to do the work without allowing indriving of rain or the incoming of birds. For this reason louvred vents should have the blades set at steep angles—such as is shown in Plate LXXXIX., fig. 1. On very exposed sides, back iron bafflers should be added. Cowl pipe vents should also be arranged with outlets for indriving rain around the sides, and all should be protected at the back with galvanized bird wire.

Ventilation to Dwelling Apartments.—The ventilation of dwelling apartments must always be carried out chiefly by means of the windows, and these should be so arranged in position, size, and character that they may be used to perflate the whole of the apartments which they serve. In this connection fanlights are often of the greatest value, especially where they are carried well up to the ceiling, for in this way they are able to clear the heated, vitiated air, which rises naturally to the ceiling. It must, however, be remembered that no means of ventilation which may be provided, be it by window or special apparatus, is of any value unless these means be put in motion by the people using the apartment. This is too often the serious fault in lack of ventilation, as both natural and mechanical means of ventilation usually require to have opening and closing apparatus, which may be readily thrown out of use by careless persons.

The value of fire-places, and especially open fire-places, should

not be overlooked in ventilation. These, when in use, create good air movement whilst the process of combustion is proceeding. It must, however, be remembered that a fire must be fed with air, and as it will draw it from the most available place, unless the fire-place be well arranged or the fire fed with direct air from outside, serious draughts may be created.

The chimney breast in a room should always be taken advantage of to build a separate outlet flue from near the ceiling, carried right up the stack, with a suitable open air outlet near the top. These flues are best of round galvanized sheet-iron pipe buried in the walling. Where apartments are without fire-places and building is of several stories, such vents may be carried up in the thickness of the walls to outlets above the roof.

The common form of outlet vent is fitted near the ceilings of apartments and passes through the outer walls. These should be carefully made complete in themselves, not communicating in any way with the wall or roof space, with smooth sides, full opening, and with a slight dip outside to prevent direct indriving of weather. Such vents are best made of sheet metal, finished on outside with a perforated face or metal baffler, and on inside with a fixed or, better still, a movable valve to suit the internal finish of the apartment. (See Plate LXXXIX., fig. 2.) Fig. 3 on the same plate shows a similar outlet finished outside with a cowl.

Where outlet tube vents are placed in the ceilings of apartments they should in every case pass right through the roof space and be finished with exhaust cowls above the roof covering. (See Plate LXXXIX., fig. 4.)

In inlet ventilation in private apartments the windows are usually depended on, though if desired some form of hopper-faced inlet may be used, of which two examples are given in Plate LXXXIX., figs. 5 and 6.

Ventilation of Public Buildings.—The ventilation of public buildings is often regulated by enactments of public authorities,

and when dealing with this class of work the designer requires to carry out the work in accordance with such regulations. As these differ somewhat in the various States, it is not expedient here to lay down actual details for this class of ventilation; sufficient to say that such cases offer difficulties quite apart from the ordinary problems of domestic ventilation.

In large halls the inlet and outlet ventilation should both be well distributed around the walls, the inlets being either through walls or windows, just above the heads of the people and so arranged by hoppers as not to cause direct draught, and fitted with closing valves.

Outlet vents, in or near ceilings, should be well divided, and these are best arranged each with separate and direct outlet, unless mechanical power be used, when the outlet may be carried along close-sided ducts and exhausted by mechanical means such as fans, &c.

In buildings where large numbers of people congregate only at certain times, all means of ventilation should be kept in motion, not only while the building is in use, but also at all other times, so that the air in the building is always fresh.

In public institutions such as hospitals and asylums, the free distribution of inlets and outlets should also be carried out, supplemented, in the case of wards, with special perflation vents under the beds as in Plate LXXXIX., fig. 7.

Warming and Cooling.—The problems of warming and cooling the air of buildings enter closely into the question of ventilation. For warming large buildings, if not by open fires, radiation by hot water is the most usual. This consists of a centrally placed boiler apparatus, supplying hot water to the various apartments by means of insulated pipes, which give out the heat at stacks of open pipes called "radiators," wherein the water circulates, and to and from which it is regulated by a valve attached to each radiator.

Radiation Heating is also carried out with electric currents by wires connected to radiators, a radiator being an apparatus in which the current is consumed in specially-made lamps, designed to throw out the heat.

Radiation is directed to warm the air actually within an apartment. On the other hand, certain systems of stove and hot air heating are designed to supply both fresh and warmed air to the apartments.

In hot and dusty weather the problem of cooling a building often presents serious difficulties, and no building which in its structure has not been designed to withstand these elements can by artificial means only be expected to successfully combat them.

Well-insulated roof coverings, properly shaded, thick, or hollow walls, verandahs and balconies, outside Venetian shutters and blinds, and properly tree-planted surroundings, all tend to counteract these evils. Apart from refrigeration much may be done, if cost is not a very important consideration, by using water sprays for cooling. Given a good supply of cool water, the inlet for fresh air may be arranged to pass through a chamber where very fine sprays of water are thrown out to cool, and wash, and lower the temperature of the air. It may then, by forced draught, be conveyed along ducts and distributed to the various inlets throughout the apartments of the building. In a small way this system may be supplied with a fine water spray playing over a porous terracotta cone at the point of inlet. Warming may also in winter be carried out somewhat on the same principle by gas-jets and asbestic cones at the point of inlet directed to the warming of the incoming air.

To move the air of apartments, and to give the sense of cooling by fanning, electric fans are of the very greatest value for summer use. The laying-on of electric current also makes possible ready means of mechanical movement for drawing in or forcing out air, so necessary when the outside atmosphere is too stagnant to act upon the ordinary means of ventilation.

CHAPTER XVIII.

PLUMBING, SANITATION AND SANITARY PLUMBING, WATER SUPPLY AND HOT WATER ENGINEERING.

PLUMBING.—*Generally.*—The practice of plumbing divides itself into three main divisions or branches—general plumbing, sanitary plumbing, and manufacturing plumbing with gas-fitting and hot water engineering as close adjuncts.

With heavy demands for certain kinds of goods, the shop of the manufacturing plumber has become more and more a speciality, separated in a measure from the work of the general plumber, who actually carries out the work upon the building.

The sanitary plumber also occupies a separate place, as his work, dealing as it does with sanitary fittings, is of such a special and responsible character that such workmen are usually licensed by boards and authorities carrying out sewerage systems in the various cities.

A sound knowledge of metals, their qualities, the best and most approved way to work, connect, and fix them, is the first essential in plumbing, together with some knowledge of the laws of hydraulics, ventilation, and hygiene.

The materials mostly used in plumbing consist of black and galvanized iron piping (welded tubing), and galvanized sheet iron, composition, lead, brass, and copper piping, sheet iron, zinc, and copper, brass being invariably used for taps and unions.

In brass or copper pipe, the pipe is described by its overall diameter to the outside of the metal. In other pipes, such as iron tubing, lead, or composition, the clear diameter of the bore only is taken. For example, a water pipe is described by the actual clear way within the pipe, such as ½-in., ¾-in., 1-in. diameter, &c.,

whereas a brass gaspipe or a copper hot water pipe is taken by the diameter right across to the outside of the metal.

Gauge.—The sheet metals are known usually by gauges. Zinc is usually numbered to denote thickness, lead being described at so much per lb. per superficial foot; copper is also sometimes similarly described, and at other times both brass and sheet copper are described by gauge.

There are several gauges used in the metal manufacturing world, the one in most common use for plumbers' sheet metals and wire being the Birmingham wire gauge, "B.W.G." or "gauge." This is a standard of thickness. A gauge may be purchased just as a two-foot rule is purchased, and consists of a metal disc with the standard cuts notched out and marked at the edges, into which the metal for testing is placed.

Imports and Local Manufactures.—All metal pipes other than those of sheet iron or mild steel are usually imported, together with the necessary connections and fittings. Sheet-metal pipes, on the other hand, are manufactured locally from imported metal, as also are such other sheet-metal goods as eaves spouting, down pipes, cowls, ventilators, ridgings, hipping, gutters, roof flat coverings, sinks, baths, wastes, &c. This class of work is bent and shaped chiefly by machinery, and should be lapped, rivetted, and double soldered at joints and junctions.

Galvanized Corrugated Iron Bending.—The universal use of galvanized corrugated iron for roofing, outside wall covering, fencing, &c., is well known. When used for tanks or curved parts of roofs the iron is bent by machinery made for the purpose.

Vents.—For cowls, vents, &c., used for ordinary ventilation, see chapter on Ventilation (Chapter XVII.)

Pipe Connections.—The following are the usual joints made in piping :—

Stoneware drain pipes ..	.. Gasket and cement
Cast-iron drain pipes ..	.. Gasket and lead caulking
Sheet iron	.. Soldered
Sheet iron to cast iron	.. Molten lead, lightly caulked

Wrought iron ..	.. Screw joints
Wrought iron to lead ..	.. Brass sleeve with lead caulking
Wrought iron to sheet iron	.. Brass sleeves
Lead pipe	.. Wiped joints
Lead pipe to sheet iron	.. Brass sleeves
Copper pipe	.. Brazed, hard soldered, or screwed
Brass pipe	.. Brazed, hard soldered, or screwed
Earthenware to metal ..	.. Bitumen.

Solders.—Solders are used to make joints and connections in pipes and metals throughout the plumbing and sheet metal trades.

The process consists in thoroughly cleaning the connecting parts and painting them over with a flux, after which the solder in a molten state is run on by means of a heated soldering iron.

The following is a list of solders and their fluxes in common use :—

Soft solder	.. Two parts tin, one part lead
Hard solder	.. Two parts copper, one part zinc
For brass . ..	.. Two parts brass, one part zinc
For lead	.. One part tin, two parts lead.

Fluxes.—

Lead	.. Resin
Zinc	.. Spirits of salts
Tinned iron	.. Resin or spirits of salts
Brass and copper ..	.. Sal ammoniac or spirits of salts.

Roof Plumbing.—For all classes of plumbing connected with roofs, see Roof Coverings (Chapter XVI.)

Sanitation and Sanitary Plumbing.—*Liquid Wastes Generally.* —The question of sanitation and sanitary plumbing is amongst the most important that can occupy the attention of the designer, and in all buildings should, from the outset, be carefully worked out and allowed for.

Sanitation has to do with the removal of all waste products from the building, and this should be done in as scientific, expeditious, and cleanly a way as possible, both with regard to the healthiness of the premises dealt with as well as to the general health of the surrounding community.

In outlying districts and in isolated premises the sanitary arrangements often leave much to be desired, but even in such cases much more may usually be done than is attempted to render such premises more habitable from a sanitarian point of view.

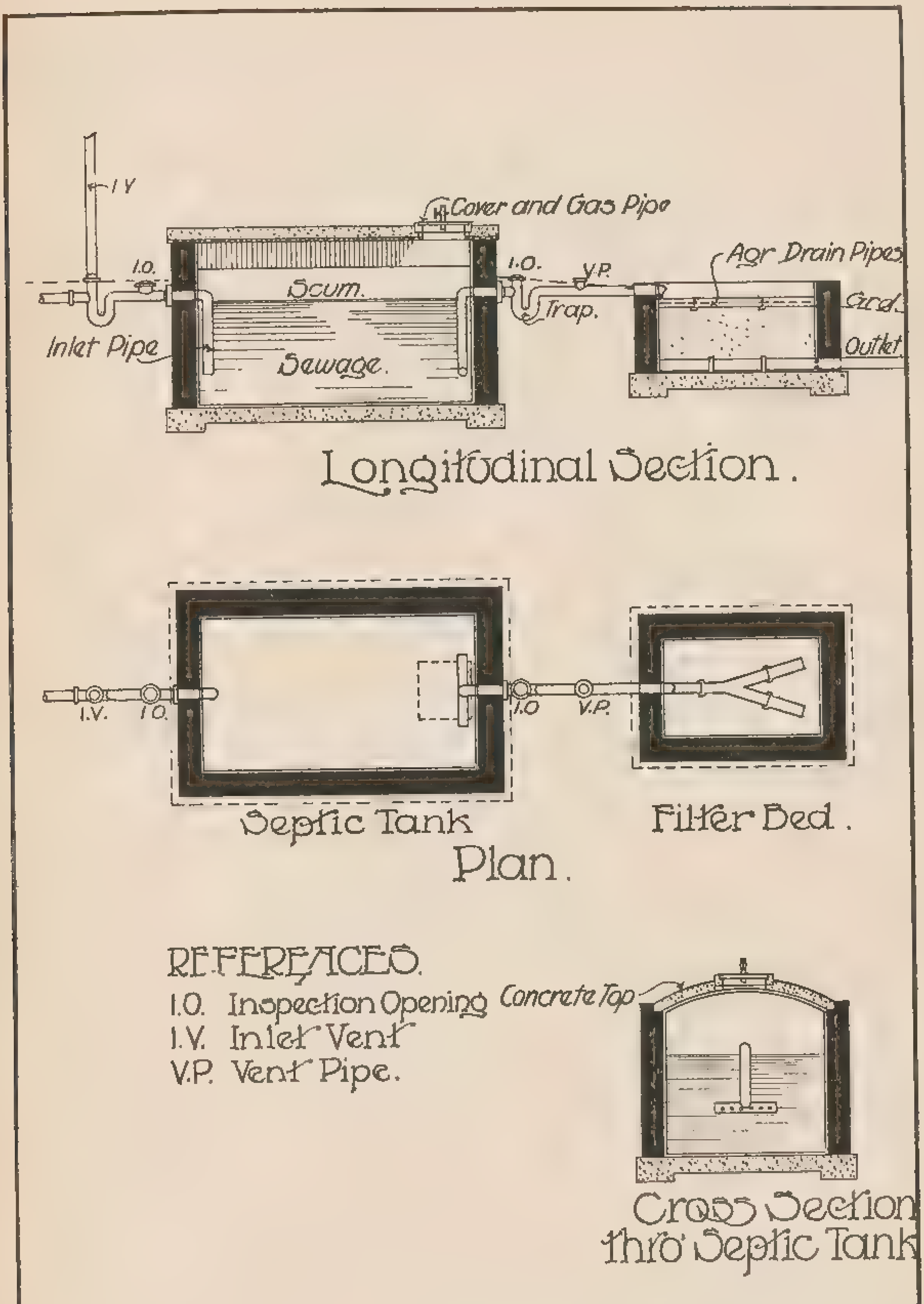
A scientific general system of deep drainage is the best known method of dealing with wastes. Such systems have now been applied to the larger cities, and are gradually being extended to the smaller cities and towns. The application of the bacterial tank system of sewerage disposal is also doing much to lessen the danger from lack of sanitation in large houses or limited communities.

The first work of the sanitarian should be to properly construct all the internal fittings in such a way as to make them as far as possible impervious and self-cleansing. For this purpose all baths and sinks should be open and uncased and of lasting material, easily cleansed, and impervious to perforation or ready decay. All wastes should be of thick metal, such as galvanized welded tubing or, better still, of lead, and all should be discharged into open air drains if a proper underground system of sewerage is not possible. In such a case, as in every case of sanitation, the fittings should be grouped together as far as possible near each other, and one upon the top of the other if the building be two or more stories in height. It should if possible be arranged upon one side, so as to facilitate one clear outfall run for the main discharge, whether it be above or under ground.

All open drains, especially the wastes, should be as short within the building as possible, and left visible, being trapped immediately under the fitting, and discharging with open ends immediately outside the wall.

All traps should have cleansing screws fitted to them and it should be remembered that a trap requires to be flushed out with clean water after it has been used, otherwise the foul water stands in the seal of the trap and causes offence till it is driven out by the next discharge.

Outside open drains should be laid to sufficient falls and with



DETAILS OF A SEPTIC TANK

easy bends, and of impervious material with close joints. The ultimate disposal of the wastes should also be looked to, and if not discharging into street channels should find some suitable outfall where the discharge may be rendered innocuous.

Pans and Other Closets.—Closets, other than water closets, should always be placed away from dwelling premises. Of these the most sanitary is the now well-recognized "double pan system," where a heavy gauge regulation pan with proper handles has to be provided. This is periodically removed and cleansed. With these closets the space for the pan should be closed, floored, and covered with upstanding sheet iron, with guides for the pan to slide in upon, and the seat well fitting down over top of pan, so as to leave as small a space as possible between.

Other systems have brick-lined cesspools, &c., but these are not to be recommended.

Refuse Disposal.—It is now fully recognized that house refuse is best destroyed by fire, and for this purpose public incinerators are better than open tips, which become, too often, breeding grounds for vermin and filth germs.

Bacterial Tank Sewerage.—For country houses or small communities the bacterial (septic) system of sewage disposal offers, if properly applied, a valuable scientific system of sewage disposal. The principle underlying the use of this tank is the fact that, if ordinary sewage be left in a darkened closed tank for a time, a scum is formed upon the top of the liquid by the action of micro-organisms which feed upon the subsequent sewage discharged into the tank, leaving only a comparatively innocuous water effluent from the tank.

Such a tank for a country house is shown in detail on Plate XC., and is arranged to receive the sewage from the house in exactly the same way as an ordinary underground city reticulation scheme would receive it, all the fittings and pipes about the house being made and fitted in the same way as is required for a first-class city connection.

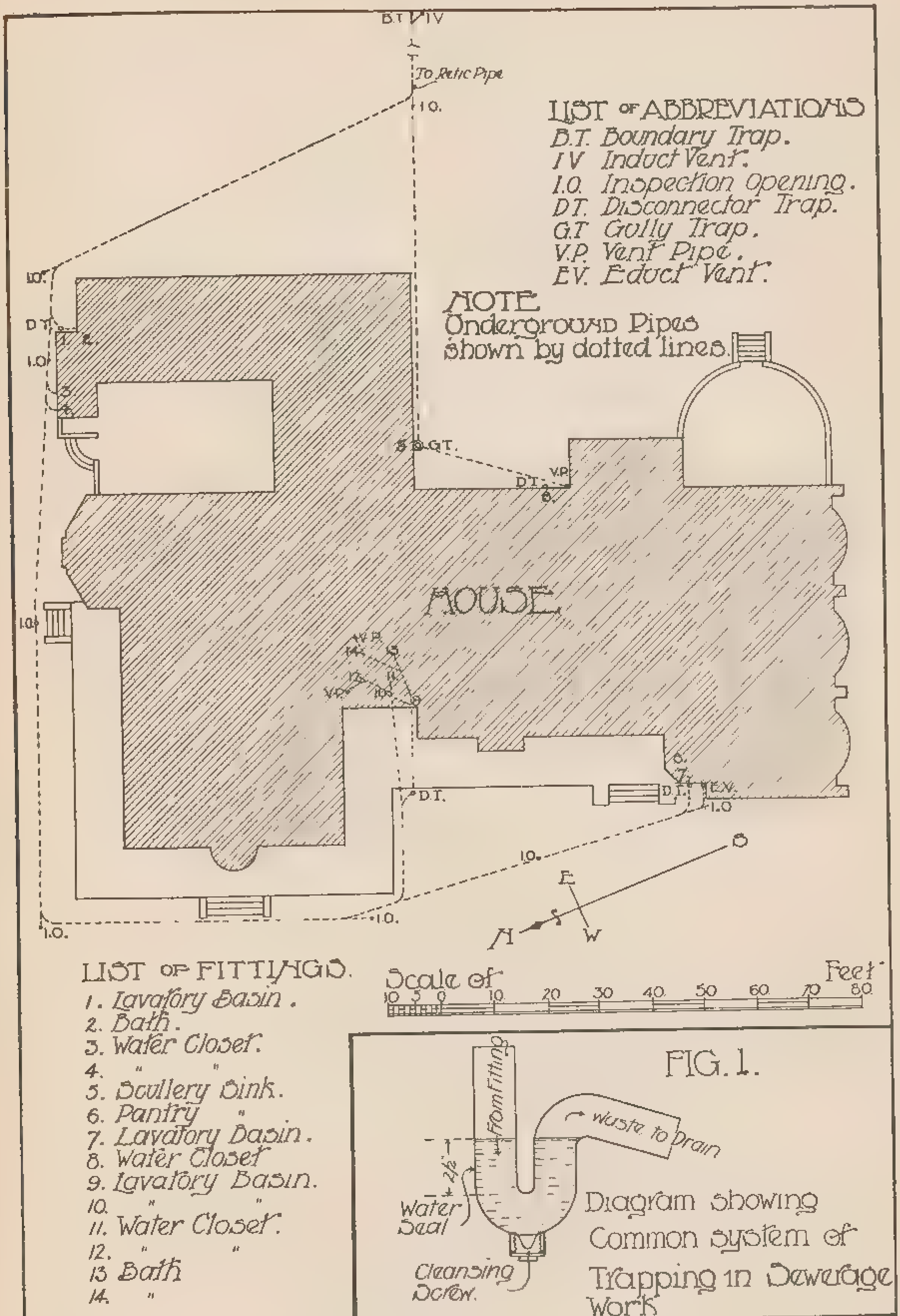
Deep-drainage Connections.—Deep drainage is now adopted by law in many of our larger cities, and the student is specially referred to the by-laws and printed regulations issued by the various authorities for the rules which govern connections within such areas.

As these laws differ in the various States, no one system can be here laid down in preference to any other, for all work carried out within prescribed areas has to be executed in strict accordance with fixed rules and under the direct supervision of public officers employed for the purpose, and also, in most cases, by plumbers and workmen specially licensed as being competent to execute and carry out such work.

As a general guide, however, some of the principles usually adopted in deep-drainage work may here be briefly described and reference made to Plate XCI., which illustrates a deep-drainage system to a large one-story house where the wastes are connected to the public sewers.

Deep drainage consists in discharging all wastes from lavatories, baths, sinks, water closets, &c., through pipes into the public sewers. In some systems the natural rain-water from roofs, &c., is also allowed to pass into the drain; in other systems this is strictly forbidden, and the rain-water has to be carried off separately, usually by open street channels.

Underground drain pipes are usually of glazed stoneware or cement, socketed for the purpose, and laid with gasket and cement joints in, as far as possible, straight runs. If 4-in. drain pipes are used they are usually laid to a fall of 1 in 40, and if 6-in. 1 in 60. 4-in. and 6-in. pipes are the sizes mostly employed, and each have their own special bends, elbows, junction inspection openings, &c. Where ground is unstable, or near large trees, the pipes should be cased in with cement concrete; where passing under buildings, the drains should be laid in cast-iron pipes—if of 4-in. weighing 16 lbs. per foot, if of 6-in. 23½ lbs. per foot lineal, with all connections to match, jointed in gasket and caulked with lead.



PLAN OF SEWERAGE CONNECTIONS

Traps are used to disconnect all fittings from the drain, and to disconnect the drain from the public sewer.

Traps are of various patterns, according to their position and make, the one general principle prevailing through them all—viz., a water seal.

This principle is illustrated in Plate XCI., fig. 1.

Traps should be arranged with water seals equal to half the diameter of the outlet pipe and never less than $2\frac{1}{2}$ inches. When of lead they should be of drawn lead.

Traps are made for certain special purposes in metal or stone ware, as required. The common kinds are boundary, gully, silt, grease, P.S., and W.C. traps. The term "disconnector" is applied to traps combining both trapping and ventilating.

Every part of a drainage system requires to be flushed with water, and for this purpose a full supply of water is always made available at the head of every fitting, the W.C.'s and urinals having flushing cisterns and all sanitary fittings and gullies being supplied with full-way taps.

Ventilation is another important factor in drainage. Every part of a drain must be subject to a free current of air by inlets at certain points and by high outlet pipes carried above eaves, so as to command free draught to cause upcasts. Traps, too, require to be so arranged and back-vented as to prevent syphonage—*i.e.*, leaving the trap dry.

Wastes from upper floors or where passing down walls from fittings, are usually of welded or cast galvanized iron, with screwed joints set in white lead, or of lead with wiped joints. Upper floor W.C. pipes are called soil pipes and are usually of special glass enamel inside cast iron, with gasket joints caulked in lead, or less often in drawn lead.

Vent pipes are usually of heavy gauge galvanized sheet iron fitted with cowls, or open ends guarded with galvanized wire.

The size, qualities, and mode of connecting all pipes, both in regard to water supply and method of discharge, are generally fixed

by law, and cannot, therefore, be specially enumerated here. It is well, however, to point out that in any well-thought-out system allowance should be made, firstly, to discharge all wastes by easy and direct flow, all corners or dead ends being by all means avoided; secondly, by the use of lasting material and well-made joints, all joints and traps above ground being visible and accessible all round; thirdly, every length of pipe, whether above or below ground, should be ventilated, and all runs and traps made free and get-at-able for periodical inspection, or clearance in case of fouling or choking.

In Plate XCI. is shown the sewerage connections to the house illustrated in detail in Chapter V., Plate IX. By following the block plan, Plate XCI., it will be seen how the various pipes are arranged, the list of fittings and the list of abbreviations making clear the connections.

In this case the public sewer is to the S.E. of the site, to which all the drains to the various fittings converge into one connection at the boundary trap.

Water Supply.—In laying down rules for water supply, the varying conditions of service have to be taken into consideration. On the one hand there is the permanent high pressure supply obtainable in all cities and many large towns, and on the other the local and often only medium pressure service obtainable in country districts from creeks, dams, or wells.

House Service.—All systems of pipe supply have much in common. For the purposes of illustration, therefore a typical water service to a small suburban house having a high pressure main service is here described.

The Main.—Main water pipes are laid under roadways and are owned by public authorities. These may not, as a rule, be tapped save under supervision and by duly licensed persons.

Pipe.—Water pipes are best of galvanized iron welded tubing with standard screwed joints and connections, all arranged so as

to give the best service to each outlet point, and kept well away from the influence of frost where frost is likely to occur.

The standard dimensions of iron pipes are $\frac{1}{2}$-in., $\frac{3}{4}$-in., 1-in., $1\frac{1}{4}$-in., $1\frac{1}{2}$-in., 2-in., and 3-in. interior diameter, sold at per 100 feet.

Bends should be so arranged as to reduce water friction as much as possible, square bends not being so desirable as rounded bends.

Lead pipes are not recommended, and are now generally abandoned. They creep—*i.e.*, get out of shape—and with age become brittle and are liable to burst under a high pressure system.

In deciding upon the size of pipes to be used, the corrosion which will occur must be allowed for in the diameter of the pipe, and the possible reduction of pipe bore after years of use estimated.

Connections to Main.—As a rule the owner of a property is responsible for the work of connection from the actual street main, even though such connection be under the footpath.

Connections to a main consist of a brass ferule stop tap and union next the main pipe and a short attached section of lead pipe leading to a further brass union connection from the lead to the iron pipe. This lead pipe is used as being more elastic when subject to vibration or subsidence of soil. Under the footpath (generally twelve inches from the building line) a stop tap is fixed contained in an iron box with movable cover. Here the whole supply to the premises may be shut off.

Meter.—A water meter is generally required by the authorities, and is best fixed as near the inside line of boundary as possible; the meter being of a regulation pattern.

Service.—One equal-diametered pipe should be maintained from the street to the end of the system within the premises. This may be, in the case of an ordinary 7-roomed house and garden, a $\frac{3}{4}$-in. diameter pipe with equal branches to principal points, such as roof tank, bath and wash troughs, and stand pipes in garden, diminishing to $\frac{1}{2}$-in. for sink and W.C. and secondary points.

Taps.—In all high pressure systems the taps must have screw-down valves. They should have, in each case, full-way bores equal to the pipe serving them, and should be of the bib or stop pattern according to position. These taps are generally of brass.

Position of Pipes.—Water pipes are best kept, as far as possible, outside a building, and may be sunk at shallow depths in the ground. Where pipes come inside they are attached to walls with light wrought-iron wall hooks.

Stock Parts.—In water supply, pipes and most of the connections are purchasable as stock articles, and only require to be handled and fitted.

STORAGE TANKS.—*Inside Tanks.*—When water is stored on the roofs or within the general area of a building, for sewerage or other purposes, galvanized plate iron tanks are usually employed. Another method is to have a lined tank—*i.e.*, a wooden box lined with sheet iron or lead. In any case such tanks should have metal trays all round, with warning overflow pipes leading to the open air in case of overflow.

Rain-Water Tanks.—Imported square plate iron tanks are sometimes used for outside rain-water storage. These are, however, not usually galvanized, and constantly need attention to save them from decay by rust.

The following data will be found useful in calculating the capacity and weight of water in tanks.

In square tanks multiply length, breadth, and depth together in feet. This multiplied by $6\frac{1}{4}$ will give the contents in gallons.

For circular tanks multiply the diameter into itself and deduct one-fifth from the product, then multiply the remainder by the depth, and the result by $6\frac{1}{4}$ will give the contents in gallons.

It should be remembered that a cube foot of water contains about $6\frac{1}{4}$ gallons and weighs about 62 lbs.

The following table gives the approximate capacity of circular tanks of various diameters and heights :—

Diameter.	Height of Tank.				
	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.
3 ft. 3 in.	200	250	300	..	..
3 ft. 6 in. . ..	240	300	360	..	..
3 ft. 9 in.	280	350	420	..	..
4 ft.	310	390	470	..	..
4 ft. 4 in.	..	..	540	..	.
4 ft. 6 in.	..	..	590	..	..
5 ft.	..	..	720	840	960
6 ft.	..	..	1,050	..	..

Outside tanks, when above ground, are usually made of galvanized iron. A well-made-up tank of this class has 24-gauge corrugated iron sides, with 22-gauge sheet-iron bottom, and 24-gauge sheet iron movable conical top. For the top inflowing of rain-water some provision is best made for screening off leaves and *débris*, while at the bottom the draw-off tap should be soldered slightly above the lowest level, so as not to disturb the sediment. At the extreme bottom of the tank a large sludge cock should be fixed, to facilitate periodical cleansing.

Underground Tanks.—Where rain-water is collected and stored, underground circular tanks of brick, smoothly and hardly rendered inside in cement, are usually built. These should be well puddled around with clay and built with a concrete floor and brick domical top, and should have a small, close cover. From such tanks the water is best lifted by means of a suction and force pump, with a supply pipe near the bottom of the tank, so arranged with a movable joint as to lift out of the sludge if required.

Underground tanks are also made of ordinary or reinforced concrete.

HOT WATER ENGINEERING.

Hot Water Supply.—Hot water circulating supply is carried out either by the use of the ordinary fire of a kitchen range or from boilers specially fired for the purpose.

The common system for domestic use is the cylinder system, where hot water from a kitchen boiler is carried to such points as baths, lavatories, sinks, &c.

Such a system consists of a more or less modified arrangement such as is shown on Plate XCII.

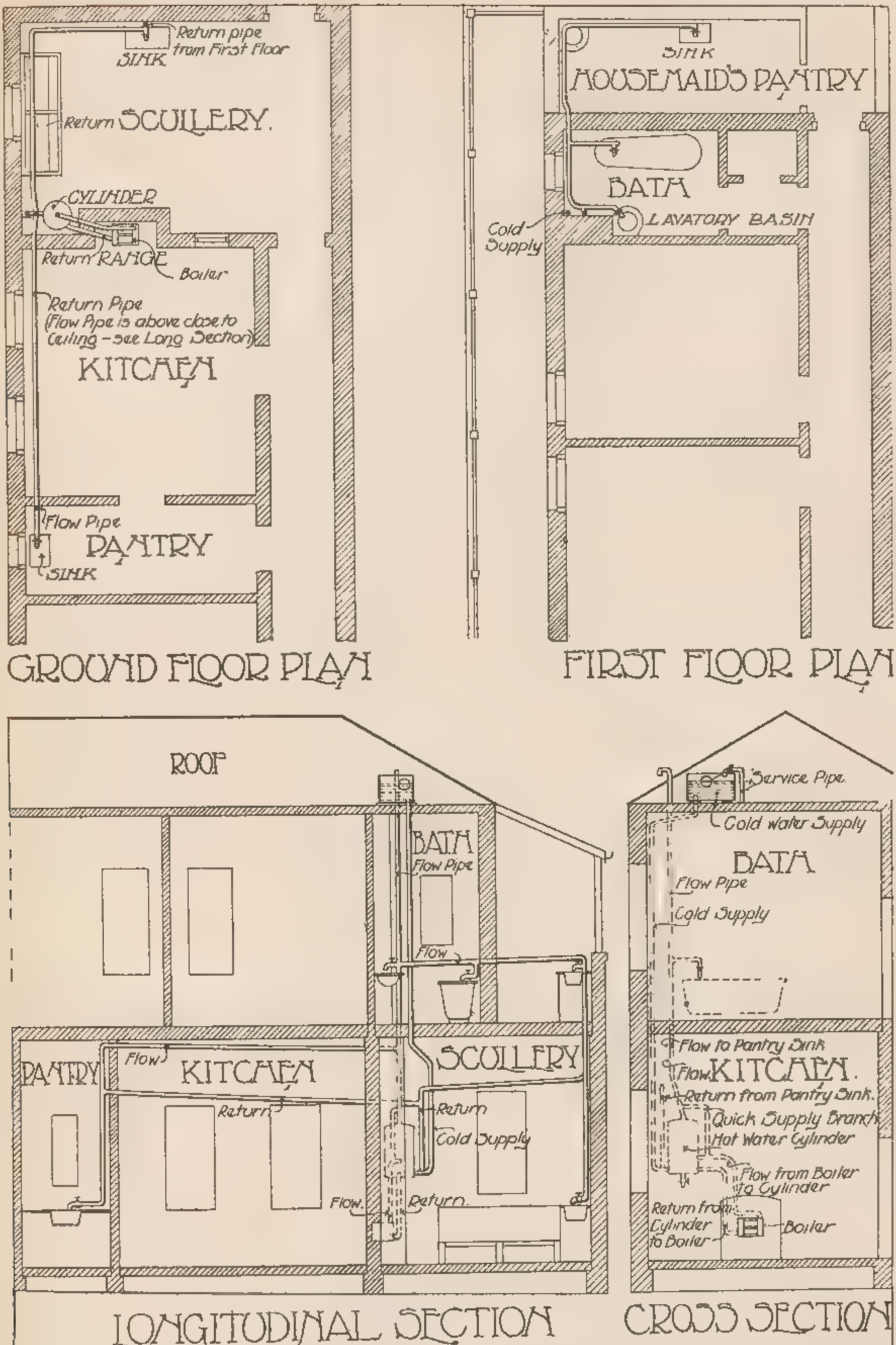
In principle such a hot water system is simple, working as it does upon the well-established facts, first that water rises to the level of its source of supply, and second that water rises when heated.

This rise of heated water is the cause of the circulation which takes place in the pipes. Immediately the water is heated at the boiler the heated molecules rise in a vertical direction and are replaced at the bottom by the colder molecules; the tendency of the hot water, therefore, is at all times to rise in the pipes and to find its way from the boiler to the hot water storage in the cylinder, and to be drawn off through the taps at the various fittings, the supply of cold water being renewed from the cistern placed at the highest point of the system.

By following closely the diagram (Plate XCII.), it will be seen how such a system works. This diagram shows the hot water service to a small hotel, the drawings of which are shown in Plate XXII., Chapter VI. Here hot water is supplied from the kitchen range to pantry and scullery sinks on the ground floor, and to bath, lavatory basin, and housemaid's sink on the first floor.

The cold water is supplied from a cistern in the roof, the inlet from service pipe being by means of a ball valve. The cold water

PLATE XCII.



DETAILS OF HOT-WATER SERVICE.

then passes down and enters the lower portion of the cylinder. The cylinder is a reservoir of hot water. Through the cylinder the hot water is taken by a short return pipe to the lower portion of kitchen range boiler. The boiler is made of twin cheeks connected together with tubes, so arranged as to offer the greatest heating surface to the fire.

From the highest point of the boiler a flow pipe is taken into the cylinder. From the crown of the cylinder the flow pipe is carried up vertically above the level of the cold supply and bent over and left open above the roof. From this main flow pipe branch flow pipes are taken to all the draw-off taps of the service.

To make clear the principle of flow and return it should be explained that water will flow (but only sluggishly) within the one pipe, but to secure an efficient service return pipes, having, if placed horizontally, a slight fall towards the boiler, should be put in. This is made clear by the arrangement of pipes shown in longitudinal section. When the hot water has traversed the system it passes into the main return pipe, which connects into the cold water supply at a point immediately outside the cylinder, and from thence returns through the cylinder to the boiler.

To ensure a quick supply, a short flow pipe is usually connected from the flow from boiler and jointed to the flow rising from the crown of the cylinder marked "quick supply branch" (see cross section).

Flow pipes, where laid horizontally, should all be fixed with a slight rise from the boiler, and all bends throughout should be as easy as possible.

In hot water supply the best work is carried out in copper throughout, with brazed joints, all hot pipes and the cylinder being carefully insulated by packing with hair-felt or asbestos cement. To make a neat external appearance the work is sometimes enclosed in wood casing or in galvanized sheet iron, but in any case all should be readily available for inspection.

The size of pipes is usually 1 in. to baths, $\frac{3}{4}$-in. to sinks, and $\frac{1}{2}$-in.

diameter to lavatory basins; these should terminate in full-way brass or nickel taps with insulated handles.

Bath Heaters.—Heaters served either by wood or gas are commonly used for supplying direct hot water to baths.

Gas Heaters consist usually of a series of copper coils connected with a cold water supply, which is brought into the closest contact possible on all sides with gas heating; or the heating may be effected by means of a fine water spray being discharged on copper sheeting heated by gas. From the heating surfaces the hot water is directly ejected into the bath below by means of an open-ended pipe.

The best of these heaters are made of copper, with close cover casings and vent flues, and have safety arrangements for lighting the gas from outside the case, by means, usually, of a small pilot light.

An admirable arrangement, which is contained in some heaters, is where the water and the gas are turned on simultaneously by means of a combined handle, thus assuring additional safety, as, should the gas be turned on without the coils being charged with water, the metal of the apparatus is liable to be quickly burnt out and destroyed.

Wood Heaters, or as they are generally termed, "chip heaters," are designed to be used where gas is not available. With these the water is heated by wood contained in a metal fire-box, the water jackets being at the top, with cold water inlet and hot water outlet, fitted much the same way as to gas heaters.

It is of the highest importance that bath heaters should have direct vent flues from them carried well up into the open air, and that they should be fitted away from direct contact with woodwork or inflammable material.

Hot Water Radiation.—For heating purposes some system of hot water radiation is often adopted. This consists of arranging

all the heating of a building from one central fire, and converting the heat into hot water, which is conveyed by means of insulated pipes. Radiators consist of stacks of open coils (uninsulated), which throw out or radiate the heat into the apartments.

The firing is done by means of specially constructed cast-iron sectional boilers placed in some convenient position at a point below the lowest pipe service, usually in a sub-basement where a rise of 1 in. in 10 ft. can be obtained for the pipes. From the boilers wrought-iron pipes with screw joints are conveyed as flow and return pipes to as many radiator points as are required.

Radiators for apartment heating are usually placed where they can the most readily intercept cold incoming air, such as under windows, near doors, and in passages, entries, &c.

The principle is also applied for heating in kitchen serveries, linen rooms, and in many other ways.

In this system the work is usually carried on by means of what is known as the two-pipe low pressure system, which consists of a cold water supply from a tank placed above the highest point leading to the heater and from the heater by means of main flow and return pipes. From these, branches are taken to the various radiators, which are controlled by means of valves, thus making each radiator independent of any other.

A somewhat similar system may be employed to supply hot water for various purposes in institutional or large residential buildings where large quantities are required.

CHAPTER XIX.

POWER, ELECTRIC AND GAS LIGHTING, AND BELL FITTING.

POWER.

THE question of "power" is of ever-growing importance in modern building, and some knowledge of the broad principles of power production and supply should be understood. We say broad principles, for the question of detail in such matters must always be left more or less in the hands of engineers specially qualified to deal with such matters.

Power plants, of themselves, usually require to be properly housed, and this phase of practice furnishes a certain class of work for the designer, while for general purposes such as lighting, ventilating, machine-driving, heating, elevator work, &c., power supply of various kinds is often used in general building.

There are four main sources of energy in common use—namely, hydraulic, steam, gas and oil engines, and electrical—and these in order we will briefly touch upon.

HYDRAULICS.—In hydraulics energy is created by water delivered under pressure in such a way as to set in motion the necessary mechanical machinery to perform the actual useful work required. The usual method in most cities is to use the energy generated at a central power station, which is reticulated, by means of main pipes, in a similar way to the gas and water services. Where this is not done the hydraulic power may be generated from the ordinary water supply by means of a gas engine, pump, &c. The elements of hydraulic power consist of—(1) The prime mover, which applies power to (2) the accumulator pump; (3) the

accumulator or pressure reservoir; (4) the reticulation (the pipes); (5) the mechanism for converting the power received into useful work.

The most common application of hydraulics in building work is to be found in the elevator.

With the ordinary elevator the practice is to balance the cage by means of weights, and to apply the hydraulic pressure to a cylinder containing a moving piston with the wheels over which the elevator ropes run attached. The latter are usually arranged to multiply the travel of the piston, so as to avoid the necessity of having a cylinder as long as the height of the cage travel. By this means the cage may be made to travel three or four times as fast as the piston, while the cylinder needs to be only one-third or one-quarter the length of the cage's stroke. The hand rope operates the valve which controls the motion of the piston.

STEAM.—The steam engine converts the energy of steam into mechanical motion. Steam engines may be generally divided into two main classes, viz.:—

(1) Those which operate on a reciprocating motion, as that of a piston in a cylinder.

(2) Those of a turbine type, which provide a direct rotating motion.

The former are in most general use, and depend on the admission of steam into a cylinder on one or alternate sides of a piston, imparting to the latter a to-and-fro motion, which is transmitted by well-known mechanical means, arranged in such a way as to give rotation to a shaft through which the required power can be taken. The control of the steam, its admission behind the piston, and its eventual release, are obtained by means of valves connected with and worked by the engine itself.

The turbine class of engine is one which is not used to any great extent in small powers, such as are likely to be met with in architectural practice, and may be omitted here.

The essential parts of a steam plant in the conversion of heat energy are as follow :—

(*a*) Fuel, combustion of which imparts heat to water.

(*b*) The boiler or steam generator, which supplies, through suitable piping, steam to

(*c*) The engine.

In a complete and well-equipped steam plant the following also may be considered :—

The superheater, in conjunction with the boiler, having a function of raising the temperature of the steam without increasing its pressure, and generally resulting in a considerable economy of fuel.

The condenser, to condense the exhaust steam from the engine, giving a vacuum at the exhaust outlet, and thus the equivalent of an increase in steam pressure.

Auxiliary apparatus also has to be considered, and may include fuel conveyors and stoking machinery, boiler feed pumps, feed water heaters, and other devices.

The efficiency of a steam plant depends on—the design of the various portions; the general arrangement and lay-out; the insulation to prevent radiation of heat from pipes, &c.; the suitability for work; and regulation of its action.

Gas and Oil.—Gas and oil engines are called internal combustion engines, since they depend for their action upon the combustion of gas or vaporized oil, and convert the heat so obtained into mechanical motion.

Briefly, the essential parts of such an engine are :—

(1) A cylinder, in which a piston moves to and fro.

(2) Valves, for the control of the cycle of operations.

(3) Means for ignition of the explosive mixture.

(4) Mechanism for transmitting the power obtained in the cylinder to be imparted to a rotary motion on the shaft, from which power is to be taken.

The mode of operation may be briefly stated :—

Assuming the engine about to start, the first thing is to obtain the fuel for the power which is to be developed. The piston being at the end of the cylinder at the commencement of its stroke, the engine must be started by hand, or other outside method, and as the piston moves along the cylinder, a charge of gas and air is drawn into the resulting space. As the engine is still moved round, the piston returns and compresses the charge of gas to a considerable pressure; and just as the piston is about to commence its second stroke the mixture is ignited, usually electrically, and the piston receives an outward impulse from the resulting explosion and starts the engine. The next return of the piston expels the burnt gas, and a new charge is drawn in, to be compressed on the next return, fired, and expelled, the engine continuing the operation in this sequence by the momentum stored in the flywheel at the impulse, to be returned by the flywheel in the compression of the charge, and in imparting a steady motion to the engine. Thus it will be seen that only every second stroke in a single cylinder engine can be a working stroke, the alternate one being necessary to obtain the charge.

Owing to the great heat involved, gas engines of any considerable power are built with a water jacket, through which water is circulated in order to keep the cylinder at a possible working temperature.

In the case of an oil engine the cycle of operation is the same, except that the oil is vaporized and used in the form of a gas.

Gas and oil engines afford a very convenient form of motor, requiring very little auxiliary apparatus and not much attendance; no certified driver is required, as in the case of steam boilers and engines.

Producer Gas.—This is a cheap form of gas which has been developed to a practical degree, and is obtained by the combustion of cheap fuel in a closed producer, and by passing steam through

the same a gas is evolved—weak in units compared to illuminating gas and vaporized oil, but capable of developing considerable power in suitably designed engines. The engine is of similar design to the ordinary gas and oil engine described above.

Electrical Energy.—Probably the most universal system of transmitting energy is by means of electricity, the development of which in recent years has given an unsurpassed means of providing light and power in a most useful, cheap, convenient, and efficient form, owing to the convenience of tapping the supply mains of the many corporations supplying this form of energy, and of obtaining it practically at any point within the network of such reticulation. The general principles of electric lighting and arrangement of same are dealt with later on in this chapter, but here it is proposed to give the outline of the elements entering into an electric installation without specially touching upon the principles of their operation.

In the first place it will be necessary to obtain an idea as to the meaning of the terms employed and their value.

To generate electricity commercially it is necessary to provide several distinct elements.

First, a prime mover in the shape of a steam or gas engine to provide power to drive.

Second, a dynamo or generator. This receives mechanical energy from the engine, and transforms it into electrical energy.

Third, conductors, usually copper wires, for transmitting the energy to the point where it is to be applied.

Fourth, application of energy so received, which is either dissipated in light, as in arc and incandescent glow lamps, &c., or it is absorbed by an electric motor, this being simply a contrivance for re-transforming the electrical energy which it receives into mechanical motion.

There are other adjuncts in many electrical plants, such as transformers and accumulators, together with the switch-gear and other apparatus for controlling and measuring the supply.

The question will, perhaps, be asked—How is it that electricity, requiring the services of a prime mover in the first place, can show any advantage over the use of that prime mover direct for mechanical energy? While it must not be taken that as a general rule electricity for power purposes should always be the best to employ, there are many reasons inherent to its nature which make electricity one of the best means of general power transmission, as well as one of the most efficient and economical. Flexibility, general convenience and ease of control, ease of conversion and transmission, absence of shafting, belting, and other transmitting agencies (an electric motor can generally be applied directly to its work without belts), cleanliness, and general efficiency all combine towards the result stated.

Electrical energy is transmitted by a current under pressure.

In electricity we have units of measurement corresponding to the hydraulic units of gallons per minute and feet of head, the standard of measurement being the ampere, the volt, the watt, and the kilowatt.

For commercial purposes the electrical energy is usually purchased and sold in units of 1,000 watt hours each, generally known as Board of Trade units or k.w. hours.

Direct and Alternating Current Systems.—Electrical systems may be generally classed under two main types—viz., direct and alternating. In the direct current systems the flow of current may be considered as a continuous flow in one direction, while the alternating current is a reciprocating or alternating flow—*i.e.*, the direction of the current is altered in the wire, first in one way, and then reversed, the rate of reversion being termed the frequency or periodicity. Applying again the hydraulic analogy, supposing in one end of the water pipe there is a piston which is moved back and forth, the water in the pipe is given a reciprocating flow, and will impart a similar motion to a piston in the other end of the pipe. This is analagous to the alternating current, and electrically the reversals are so rapid as to be imperceptible in a lamp viewed

by the ordinary observer. The rates of frequency most in use are —25, 40, 50, or 60 cycles per second.

The alternating current has many advantages over direct current in certain work, and may still further be divided into single phase and polyphase systems. The single phase is that which has just been described as an alternating current system, while in polyphase systems several of such reversals take place in sections, depending upon the number of phases employed. For instance, in a two-phase system there would be four wires, consisting of two distinct alternating current circuits generated by the one machine, and in three-phase there are three such wires and a similar number of poles.

Relative Application of Direct and A.C. Systems.—The relative application of direct or alternating current to the work which is under consideration will, of course, be determined in regard to the particular nature of the work and the nature of the power adjacent. A consideration in determining this will generally be found in the system of distribution adopted by the power corporation supplying electrical energy in the district, and generally, though not always, the individual system will be laid out accordingly. General experience among engineers has shown that for ordinary city distribution, where a considerable amount of electrical energy is required within a limited area, the direct current, three-wire system is the most suitable, while for suburban distribution and transmission over distances the alternating current system is usually adopted.

In the same way the voltages to be used will be determined by practical considerations.

ELECTRIC AND GAS LIGHTING.

Electric Lighting.—The question of the supply of electric energy and the fitting up of lighting installations to buildings is highly technical, and requires, at all times, expert oversight and trained labor.

Some uniformity of practice is now adopted by the leading municipal and private corporations supplying electric energy throughout the Commonwealth, with the result that standard rules for wiring are so laid down as to secure certain definite conditions, which must be made to exist in the wiring service before energy is supplied to the building.

In seeking information, therefore, upon lighting, where the energy is supplied from services outside the building, a copy of these rules should be obtained from the corporation supplying the energy, and a detailed specification of the work required drawn up by a competent electrician in accordance both with such rules and also with the requirements of the fire insurance companies.

The actual production of energy is, as a rule, outside the range of the building altogether, though in isolated instances, such as manufacturing premises, mines, &c., where removed from corporation supplies, separate electric light and energy plants are run. These for the most part are, however, not within the scope of ordinary building practice, and need not be specially touched upon here.

All electric energy is carried by means of wires, and these must be protected by every means from direct contact with each other, and also from friction and the action of damp. It is also to be understood that the size of wire employed has to be proportionate to the electric current which it has to carry. For all such information the student should refer to the standard general rules for wiring, for the utilization of electrical energy before referred to.

Lamps.—The nature of the illumination to be obtained will determine the question of considering any special form of lighting, such as whether the lamps shall be of the arc or incandescent type, and in the case of special industries such as photographic and lithographic requirements, the question of the nature and quality of the light will be considered, and lamps chosen to suit the work. For example, the Nernst lamps, giving a soft white light, are

frequently preferred for jewellers' shops, the mercury vapor lamp for photography. In cases where electric energy is expensive the installation of high efficiency lamps may well be considered. Lamp renewals are sometimes undertaken by the current supply authorities.

For the installation of glow lamps the candle power of each lamp should be given—8, 12, 16, and 32 C.P. being those mostly used.

Fitments.—A very large and ever-increasing variety of apparatus of all kinds is now stocked by electrical supply firms, such as lamps, brackets, movable lamps, &c., and these may be priced, specified, and selected as required.

Technical Terms.—The following is a brief glossary of some of the leading technical terms used in electric lighting.

Blocks (*or Patera*).—Small pieces of shaped and prepared wood used for fixing fittings to walls, ceilings, &c.

Cable.—A number of wires twisted together, forming a flexible conductor; these may consist of a single conductor or two or more conductors under the same covering and insulation. In the latter case they are called two or three-wire core cables as the case may be.

Casings.—The protective coverings used to case in the conductors (wires). Casings are of three leading kinds—wood, split steel tube, and welded tubing with screwed joints.

. *Ceiling Roses* are small non-conducting devices used to receive flexible wires in ceiling lamps.

Circuit.—A term applied to the continuous wires or cables feeding a lamp or group of lamps. A circuit usually begins and ends at a switch or distributing board.

Conductors.—The specially prepared wires or cables used for the conveyance of current.

Distributing Boards.—A non-conducting and non-combustible panel upon which is mounted the necessary fittings for splitting up the supply for distribution to two or more points.

Fittings.—A common term referring to electroliers, spiders, brackets, special lamps, shades, reflectors, fitments, &c., used in lighting.

Flexible Wire.—An insulated conductor consisting of a number of fine wires stranded together, by which lamps are suspended.

Fuses (or "Cut-outs").—Devices designed to fuse should the current be too great for the circuit

Lamp Holders. -Metal fitments for holding lamps or lamps and shades of various kinds.

Meter.--An instrument for reading currents or energy consumed by the service.

Service Lines.—The lines outside the building owned by the authorities supplying the energy.

Switches.—A device by which the continuity of the circuit into which it is connected is mechanically interrupted and made at will. A switch may control one or more poles.

Wall Plugs.—Fittings designed to receive flexible wire attachments, such as movable fans, lamps, &c.

Ordinary Wiring System.—The first point of consideration in an ordinary wiring system for lighting a building is the "main safety fuse" or fuses. These fuses consist of devices for automatically disconnecting the supply current from the main to the building in case of accident and are usually supplied and fixed by the supply authorities.

The next point is the meter, which measures the current consumed, to which the main supply cables are connected. This is also furnished and fixed by the supply authorities.

From the meter cables are carried to the next point—the main distributing board or boards, upon which are placed the main switches for controlling the current.

From these boards the wiring is taken, in the most direct and convenient way, to the various points and switches throughout the building.

The principle of this system is shown in Plate XCIII., fig. 1, which illustrates a common method of dealing with a small system. Under the rules the lights have to be grouped in limited numbers, only a certain number being allowed upon any given circuit.

The diagram shows how the energy is distributed—first, incoming at the main, it passes through the main safety fuse, thence through the meter to the double-pole switch, and so to the sub-circuit fuses. From each of these fuses a circuit, consisting of a leading wire from one pole, with a given number of branches off to the various switches controlling the lights, thence to the lamp, and from lamp to return leading wire, which connects at the board to the other pole of the sub-circuit fuse, is carried.

This sub-circuit arrangement, of leading wire carrying so many lamps, is repeated till the whole of the service work is accomplished, the connections each time being made upon the board through fresh sub-circuit fuses, the general rule being that every subdivision requires a separate fuse.

The common method adopted in carrying out the work is to commence with the points at the greatest distance from the distributing board on each floor, and to arrange these in groups up to the limit of load allowed, and to then run back with the double wire to the safety fuses on the distributing board and so repeat till the whole of the points are connected.

The gauge and quality of the wire and covering used is regulated by the conditions of supply, and is generally size No. 18 or No. 16 S.W.G., commonly termed " house wire."

For convenience of handling and picking up, a good plan is to use wires of two different colors, say a red wire for the positive and a black wire for the negative or return wiring.

The wires must always be protected from damage, and laid either in wood casing or metal tubing made for the purpose, the wood casing being mostly used in situations where the conductor runs are visible, and the metal tubing where runs are under plaster or in other hidden positions. In damp situations the

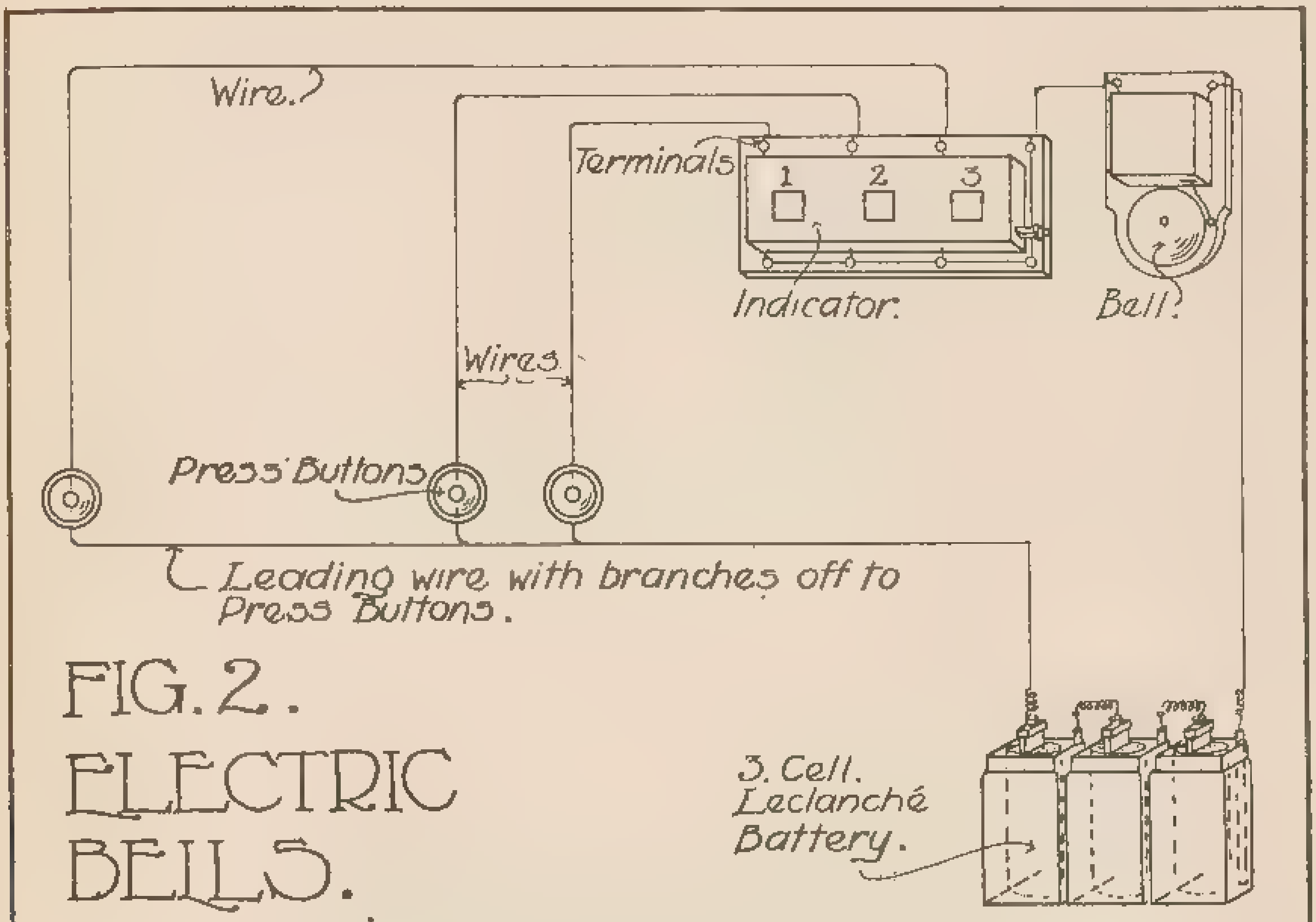


FIG. 2.
ELECTRIC BELLS.

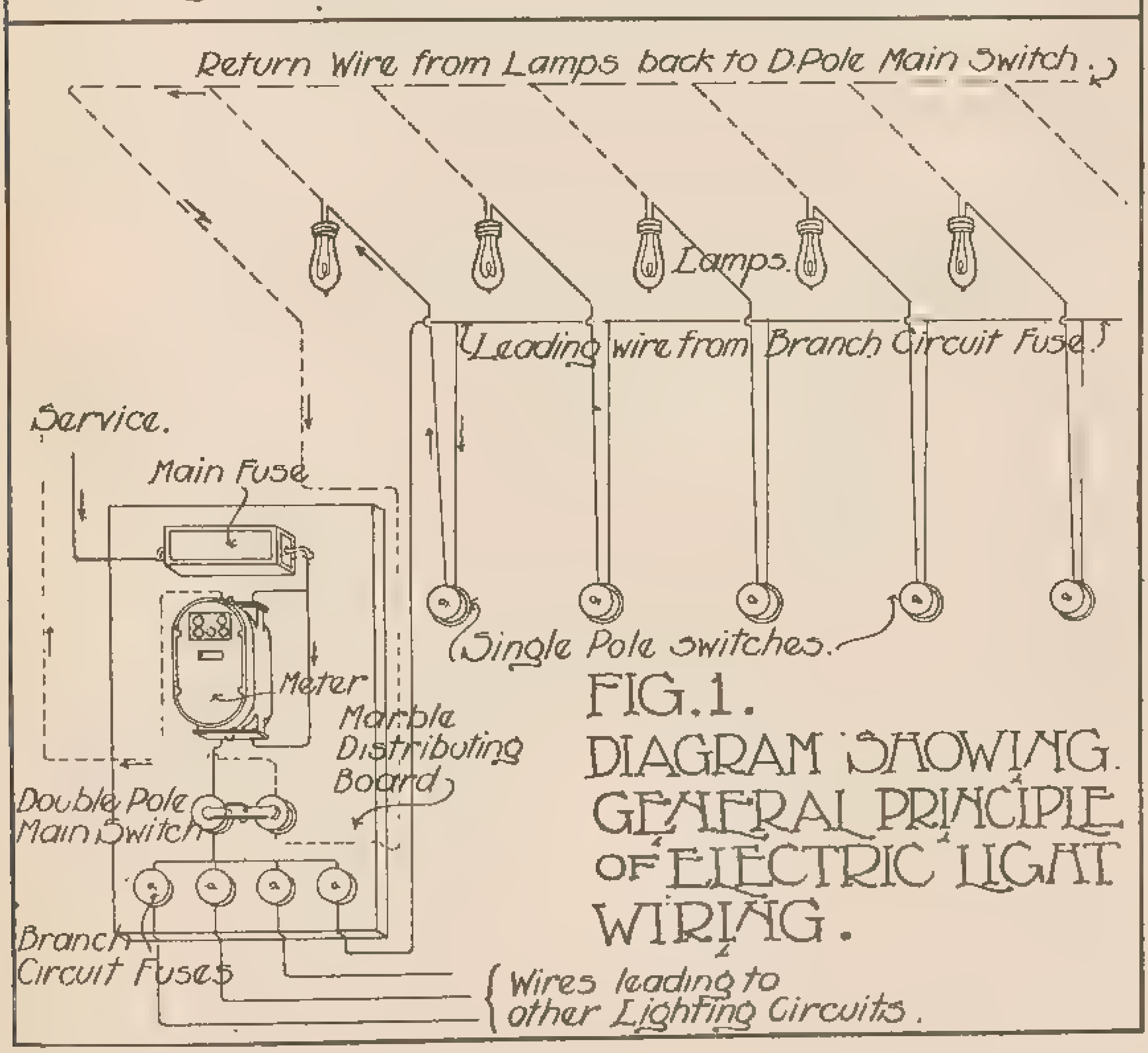


FIG. 1.
DIAGRAM SHOWING GENERAL PRINCIPLE OF ELECTRIC LIGHT WIRING.

wires should be enclosed in galvanized welded tubing with screwed joints. Metal casing is to be preferred to wood in all good work. The subsequent convenience in the picking up of wires should always be specially considered in the laying of all wiring systems, and the circuits should be labelled for identification.

In large buildings, as in the case of offices or flats in different occupancy, it is necessary to instal cables enclosed in galvanized welded tubing with screwed joints to the several floors and suites, where they may be connected to meters as required, and the wires distributed in the usual way, either for light or power. By this method no master meter is required, each tenant having his own meter.

In this class of work a good workable system is to carry a pair of wires from each apartment to some central point upon each floor, where the cables terminate, so as to facilitate any change of occupancy or meterage that may subsequently occur.

Gas Lighting and Fitting.—*Main Pipe.*—For general purposes of supply, where coal gas is used, black iron piping is best, as it does not corrode so readily as galvanized iron. This pipe should be of the quality known as "welded tubing," which may be purchased with all the necessary screw connections, such as elbows, tees, diminishing and equal sockets, stop ends, &c.; these are screwed and fitted together with red lead.

Meter, &c.—As coal gas (unlike acetylene) is always manufactured at a distance, and supplied to the consumer through street mains, the first requisite of the supply is a meter to register the quantity of gas consumed. This meter is supplied by the gas company, and is fitted up and set under the control of their servants.

The meter should be fitted up in a place easy of access for reading, and must be at the lowest point of the system, all pipes being laid with a fall towards the meter, so as to allow any condensation in the pipes to find its way back to the meter, where it may be drawn off.

For the same reason, pipes should be laid without hollows or syphons, as water condensing in these would stop the passage of gas.

Stop Cock, &c.—A stop cock, with reversible handle, is first fitted on the main side of the meter; this enables the supply to be shut off or turned on from the meter. The immediate connection from the main, and to the service from the meter, often requires sharp turns; for this reason, flexible lead pipes with brass connections may be used. For the purpose of illustrating an ordinary system of gas-fitting, the gas supply to an ordinary villa, with outside workshop, may be here described.

Gas Service to Villa.—Beginning from the meter, a 1-in. or $\frac{3}{4}$-in. rising main is carried up the wall to ceiling, and thence along on top of joists over the various apartments, and connected with $\frac{1}{2}$-in. branches to centre lights, and $\frac{3}{8}$-in. down walls to bracket points. The pipes down walls should be of brass, as it is rigid and thin, and lays well under plaster. Compo. pipe should be avoided, as it has many disadvantages, and is not allowed in good work; it is liable to sag between fixed points, to fracture at the joints through changes of temperature, and is also peculiarly liable to damage through nails being inadvertently driven into it when the pipes are buried in plastered walls.

Pipes are secured to walls with iron wall hooks fixed to plugs in joints of the brickwork. Pipes over the ceiling require to be carefully laid, and secured to wood cradling laid to true and continuous falls.

In carrying the supply pipe to the workshop, the pipe, being an outside one, is specially liable to cold air condensation; it should therefore have at its lowest point a small continuation piece with tap for drawing off moisture.

As incandescent fittings are now almost universally adopted, it is essential that a good and uniform pressure should obtain at all points, so as to ensure an even and full gas supply; the pipes,

throughout the system, should not, therefore, be reduced in size to any appreciable extent.

Fittings.—Gas fittings are either secured to walls as "brackets," or hung to ceilings as "pendants."

A wall bracket requires a right angle elbow at end of the supply pipe, into which a short threaded piece of tube called a "drop screw" is inserted. This projects well out beyond the wall face, and is encircled by a wooden fixing block plugged to the wall. The gas bracket tube is screwed into this drop screw, and the bracket collar fastened to block; in this way the weight of the fitting is received by the wooden block.

A ceiling pendant is secured by a hanging block—*i.e.*, a block of wood bridging across top of joists, through which a pipe passes.

The supply is taken off the supply pipe by an elbow or tee piece, turned down, into which a short length of pipe, called a "hanging rod," is threaded and passed through the ceiling. This rod has a back nut upon the top of the hanging beam which holds the rod in position. The connection to the pendant fitting is then made, the block taking the actual weight of the fitting, and the hanging rod making the gas tube connection.

Large Systems.—Other systems of gasfitting are carried out much upon these lines, save that in more extensive systems, as in office buildings, the pipes require to be larger, and several separate meters and services may be fitted in the one building.

Stoves, &c.—Where gas is used for cooking and heating purposes, such as for cooking stoves, bath heaters, &c., a generous supply pipe should be carried direct to fitting, according to normal pressure required, a $\frac{3}{4}$-in. pipe being generally found sufficient for ordinary purposes.

Test.—All pipes should be so laid as to be as far as possible get-at-able should repairs be required, and the whole system carefully tested before being passed for use.

ACETYLENE.—In country districts, or in positions away from the

supply of coal gas, an economical and practical illuminant is secured by the use of acetylene, which produces a white light of strong actinic value.

This gas is produced in small or large quantities by the contact of calcium carbide with water. This carbide is manufactured from lime and coke under enormous heat generated by the electric arc, and is imported, chiefly from America and Sweden, in metal drums ready for use.

The manufacture of gas for an ordinary house installation is carried on by means of a metal "generator," which usually consists of a water tank, a carbide holder, and a gasometer.

The process of making the gas consists in saturating the carbide with water.

Generators.—The most approved generators are arranged to drop granulated carbide automatically, in small, regulated quantities, into the water, and produce a limited quantity of gas at one time as actually required for consumption. This secures safety and economy, and the process is repeated and continued as long as the lights are burning and the gas consumed.

A generator should be placed in some convenient outhouse or in the basement of the building, to which water is made available. A well-ventilated apartment with impervious floors is best. The generator should be set up slightly above the floor, and have air freely circulating all around the apparatus. These generators require to be recharged with carbide from time to time, to have the water renewed, and the by-products of lime taken away.

Pipes.—The pipes may be of the same kind as for ordinary gas, save that, owing to acetylene having more natural pressure than coal gas, the diameter of the pipes may be reduced some 20 per cent. The joints, too, should be specially well made (those in iron pipes being made with white lead), as this gas is very penetrating.

Burners, &c.—The burners for this gas are specially made with

lava tips and extra small perforations, the common kind being classed to consume $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1 cubic foot of gas per hour.

In addition to lighting, acetylene may be used for cooking and heating.

Wood Gas.—Gas, both for lighting and gas-engine power, may be generated from many of our local woods—gum, peppermint, &c. A plant to produce this consists of an apparatus containing an air-tight retort, a tar vessel, and a gasometer. The by-products of this manufacture are tar and charcoal, and some 250 cubic feet of gas may usually be extracted from a piece of wood measuring 2 ft. long by 5 in. square.

A retort of this kind is usually built in connection with a kitchen fire-place, so that the same fire is available for cooking and other domestic purposes.

BELL FITTING.

The old time system of crank bells is now obsolete and only exists to a very limited degree in old buildings, the same being true also of pneumatic bells, worked by air pressure.

Bell fitting for modern work is now invariably carried out by the electric battery system, which consists of a galvanic battery, generating a weak electric current conveyed by wiring through a system consisting of press buttons, which, upon being pressed, give an alarm signal to a central bell and indicator.

All fitments and goods for electric bell work are now purchasable, and only require skilled labour for fitting them up.

Plate XCIII., fig. 2, shows briefly in diagram the general principle of electric bell fitting.

The "battery" supplies the current and has first a carbon pole, from which a leading wire is carried to the "press button" and from thence to the "indicator." A return wire is then laid from the indicator to the "bell," and from thence to the zinc pole of the battery. In this way a complete circuit is created by making contact at the press button, and this contact through the press

button sets the bell ringing, and also shows a signal upon the indicator.

In large systems any number of branches may be taken off the leading wire.

In its simplest form bell fitting consists of connecting a wire from one pole of the battery to a press button, and from thence through a bell back to the other pole of the battery, contact being made at the press button.

The Leclanche battery is the type of battery usually employed. This consists of a glass jar containing a porous pot and zinc rod covered with a solution of sal ammoniac.

This supplies the galvanic power required, the number of batteries being increased according to the number of bells used. A four-cell battery will be found sufficient for any ordinary building, as bells are never all working at one time and only a weak current is required at any time.

Batteries should be placed in positions away as far as possible from the influence of evaporation, and yet so as to be easy of access for cleansing and renewal of solution.

Dry batteries of carbon manganese and a saturated solution of sal ammoniac are sometimes used, but are not recommended.

Press buttons vary greatly in pattern, the principle remaining the same—namely, a non-conducting pip or button which upon being pressed brings a metal spring into contact with the second wire, thus completing the circuit by bringing the two wires into contact, and so ringing the bell.

For outside positions, where the press is exposed to rain, the press apparatus should always have a barrel—*i.e.*, a metal enclosing case.

For general use 20 or 22-gauge wire covered with india-rubber, double-cottoned and paraffined, is best. This should be protected by every means from the action of damp or corrosive acids and so laid as to be easily get-at-able in case of necessity.

In attaching wires to existing work, the wire in duplicate is

generally carried along on top of skirting and around architraves, &c., and secured at distances of about 12 in. with metal staples, care being taken to well pad between the staple and the wire to prevent cutting.

In new buildings the wires should be laid out of sight, in a complete system of tubes, to protect them from outside damage.

For all general purposes zinc tubing is used, while for high-class work enamelled steel simplex tubing with socketed joints is best.

In fitting up a bell system to a new building, full regard should be had to its future working, and the runs so arranged that wires may be drawn out or new wires inserted at will without moving the tube.

The roof is generally a suitable place in which to carry long runs. Where tubes come down walls they must be well under the plaster, and where under upper floors screw down boards should be fitted at the end of the runs. Spaces under ground floors are best kept free from wires, as there is more often danger of damp in such positions, and damp should in every way be avoided; for this reason also tubes should be placed so that condensation should find its way out of the tube should moisture accumulate.

Bells vary greatly in pattern and tone, the ordinary $3\frac{1}{2}$-in. or 4-in. vibrating bell being the pattern most in use for domestic work. For varying the sound, single stroke bells or "buzzers" may be used. All these are fitted with coils.

Where a number of apartments are fitted an indicator is commonly employed to supplement the bell. This consists of a wooden case with glass front, partly obscured, and so painted as to show certain discs; at back is a movement device, to show which press button is being operated upon, the names of the apartments fitted being clearly painted on the case over the disc holes. An indicator movement falls in front of the disc, and may be reversed either mechanically or electrically, the latter being generally found the best as saving mechanical friction and wear.

CHAPTER XX.

PLASTERING.

Plasterer's Work.—The work of the plasterer consists of coating internal and external wall surfaces, ceilings, &c., in plaster or stucco, and in running ceiling molds, executing outside rough cast work, &c.

Manufacturing.—A certain amount of workshop manufacturing is identified with the plastering craft, such special work as the modelling and pressing of ornaments, the manufacture of fibrous plaster ceilings, cornices, and ornaments being produced as manufactured articles.

Plasterer's "Stuff."—All "stuff" for plastering must be kept free from the contamination of loam, vegetable matter, or salt. The sand must be sharp and clean, the lime thoroughly well slaked, run, and strained through fine-mesh sieve, to remove hard nodules, and all lime stuff mixed up and left to ripen at least fourteen days before use.

Cowhair is used in plastering to toughen the stuff. This should be long and thoroughly beaten and teased, to keep the fibres well apart, so that they may mix well when in use.

Cementing "Stuff."—For cement stucco (generally called cementing) Portland cement is used, mixed with sand. For finishing coats the sand is best washed in running water.

Plaster of Paris.—For fibrous ceilings, internal ornaments, and similar work plaster of paris is used.

Keen's Cement. -For specially hard white finish, such as external projecting angles of internal walls, Keen's cement is used. This is a very hard-drying white cement. Keen's must always be backed up with Portland cement (not lime plaster).

Ready-for-Use Material.—Patent manufactured plasters and cementing material, purchasable ready for use, are also used in limited quantity in modern work.

Lathing.—Ceiling joists, wood partitions, &c., to be plastered are first close lined with laths. These are thin, long, flat strips of wood set parallel to each other, and nailed to the structural woodwork, having between each a space called "a key," for the first coat of plaster to squeeze through and form a key or grip.

Laths should have broken end joints, not more than 18 in. of end jointing being together in one line, and all being close nailed with thin flat-headed lath nails, and set to full $\frac{3}{8}$-in. key.

Laths for walls require to be wider and stronger than for ceilings. Ceiling laths should be narrow, so as to produce more key. There are "wide" and "narrow" laths in the market, sold in bundles, those known as imported (American) being mostly used.

Expanded metal may also be used for lathing. This consists of stamp-cut, mild steel sheets drawn out in the form of a trellis, which offers a uniform key for the plaster.

Ordinary Internal Plastering.—Ordinary internal plain-faced plastering is best done in three coats, known technically as "rendering," "floating," and "setting," each coat being left to dry before the succeeding coat is put on.

The first coat ("rendering") should be well pressed and squeezed against the laths and into keys, and rendered over wall surfaces, which are best damp and rough. This forms a thin, tough coating, which is scratched all over to form a key for the second coat.

The second coat ("floating") is laid upon the first coat and brings the work to a finer surface, care being taken in this to keep the surfaces on true planes. This is done by screeds—*i.e.*, temporary wood battens or strips of plaster set parallel at wide intervals and to the surface level of the second coat. From these a traversing rule is worked to cast off the superfluous "stuff."

The third coat ("setting)" should be very thin, smoothly, evenly, and cleanly rendered to a fine face.

In internal plastering the internal angles are first of all plumbed upright in the "floating," all wall planes being worked therefrom. For ordinary house work a wall is worked in two heights—from floor to half-way up, and thence to ceiling.

The following is a working formula for ordinary plastering stuff to finish about $\frac{3}{4}$-in. thick:—

First Coat.—Three parts of sand; one part of lime knocked up with cowhair—proportion, $\frac{1}{4}$ bag of hair to 4 bags of lime.

Second Coat.—Four parts of sand; one part of lime, and very small quantity of cow hair.

Third Coat.—One part of fine white washed and sifted sand; three parts of lime.

This is known as "setting," and should be trowelled with steel trowel to hard face.

A pure white finish, known as "putty plaster finish," may be produced by substituting as third coat the following:—Four parts of lime putty (slaked lime allowed to stand till of the consistency of putty), gauged with one part of plaster of paris.

Angles.—The external projecting angles of wall plastering require to be specially dealt with, the ordinary plaster not being sufficient to withstand the danger of breakage. The best approved method of finish is to back in the angles, for a width of about 2 in. on either side, with Portland cement and sand four to one, finished $\frac{1}{8}$-in. thick with Keen's cement to polished even surface cut to true line. Such angles may be molded or chamfered.

These angles are finished before the final coat of plaster on the wall is completed, the hard, true angles being used as guides, and the cut vertical lines for the plaster to finish against.

Cornices.—The old method of running cornices around internal plaster ceilings is rapidly giving way before the introduction of the fibre cornice.

Cornices or moldings on ordinary plaster may be run in "gauged

stuff"—*i.e.*, lime, putty, and plaster of paris—the mold contour being cut out in zinc, nailed to rough wood frame, the whole working along horizontal screeds to clean, white, smooth finish. In this class of work the surface is first roughed in with coarse hair stuff, roughly shaped with a "muffler"—*i.e.*, a cut-out mold contour about $\frac{1}{8}$-in. less than the true mold.

In carrying out internal plaster features of any kind it is considered unsafe to allow a thickness of more than $2\frac{1}{2}$ in. in any part of the work. When thickness is excessive it should be keyed with copper wire and nails.

LIME STUCCO.—In preparing internal surfaces for painting or decorating, the final coat may be in "lime stucco," half sand, half lime, worked up with a felt float. This brings up a scum, which scum before it is dry is trowelled back into the work with steel trowel. This when finished gives a hard, glass-like surface.

FIBROUS PLASTER.—Fibrous plaster, or "fibre," as it is commonly called, is much used for ceilings. This material has the advantage of possessing great tenacity and strength, and, being rigid, and in large pieces, self-contained, it may be readily fixed in position, without danger of falling away with the wear of time, as sometimes happens with ordinary plastering.

Fibrous plaster also gives opportunity for enriched surface work, which may be repeated again and again from the same molds, and worked to interlock and continue in various panels and continuations, for ceilings, filling, ribs, cornices, columns, linings, pilasters, ventilator faces, &c.

Fibre is a manufactured material generally made as follows:—The work is first modelled, then cast, and molds produced; into these molds liquid plaster of paris is first of all poured, upon which coarse, open hessian is laid. Long Oregon laths (about 1-in. by $\frac{1}{8}$-in.) are then interposed and covered with another layer of hessian, plaster being poured over all to bring it to the necessary thickness.

A modification of this process is adopted according to the class of work to be produced. In the case of heavy work the parts are strengthened by the addition of galvanized wrought iron, hoop iron, or wire bedded in the work.

Cornices are generally made in lengths from 3 to 10 feet lineal, and ceiling fillings in sheets up to about 20 ft. super. per sheet

Fixing Fibre. -For fixing this material, deal or Oregon battening should be firmly fixed at proper intervals, to which the fibre may be secured. Cornices, if widely projecting, require wood bracketing at intervals. Ordinary filling is secured with clout-headed galvanized iron nails, and cornices and special cover and heavy projecting pieces with screws. These fixings should be as much out of sight as possible. Where through the visible work, they are countersunk, and filled over fair with plaster of paris.

Internal Enrichments.—Centreflowers are ornamental enrichments modelled and cast and produced in plaster of paris; these are placed on plaster ceilings round lighting pendants, and to form ceiling vents, &c. They are made in a great variety of patterns and often in several parts, and are easily secured in position with plaster of paris.

Plaster wall faces are manufactured in the same way to cover outlet vents through walls near ceilings.

Other ornaments, such as pilaster caps, bosses, ribs, moldings, and enrichments of all kinds to plastered work are also produced in the same way.

Outside Cementing.—Outside cement work of all kinds is best done in damp weather, freedom from actual rain or frost on the one hand, and from excessive dryness on the other, being advisable.

Cement work should always be kept damp. The surfaces upon which it is laid should be wetted, and, if practicable, rough to form a good key, and the work should be kept moist for at least seven days after completion.

The term "stucco" is sometimes applied to cemented surfaces, but it is not of altogether general application, ordinary Portland cement and sand work being generally referred to as "cementing."

Ordinary Cement Rendering. In all cement work the nature and character of the Portland cement used should be ascertained, as the strength and time of setting varies greatly in this article. Coarse sand is best for first coating, and fine washed sand for finishing.

The following is a workable recipe :—First coat ("floating").—Four parts of sand, one part of Portland cement, gauged clean and used fresh and laid evenly on to the walling in a ¾-in. thick first coat.

After first coat has set, second coat ("finishing"), with a ¼-in. thick finish, compounded of 2½ parts fine sand to one of cement.

The finish may be brought to hardness by the steel trowel or to a granulated (sand) surface by wood float.

Cornices, &c.—External cornices are run in a similar way to internal cornices. When on rough stonework three coats are sometimes necessary, but in the usual way only two are required, the stuff not being gauged too rich, otherwise fine cracks may occur.

Pressed Cement.—Enrichments and ornaments are generally produced in pressed cement, which is manufactured as follows :—

The work is first modelled in clay and cast in plaster of paris piece molds, which are well coated with shellac. "Stuff" of Portland cement and sand gauged two or three to one is then mixed and pressed into the molds with ramming tools. When slightly set the molds are removed piece by piece, and the work laid out upon drying boards, trimmed, and afterwards kept moist by watering for several days till hard.

In gauging the cement and sand care should be taken to thoroughly mix the two, and to wet so that the mortar may be damp through without being sloppy.

Pressed cement work may be attached to stuccoed surfaces with

cement mortar, and strengthened with galvanized iron hooks, nails, or clips.

Rough Cast is rough-surfaced stucco, generally applied to outside surfaces, such as gables, walls, &c.

It is either done on laths, as when applied to timber work, or directly on to solid walls.

When upon laths the lathing should be done with stout, wide laths or expanded metal. The first coat consists of haired stuff (same as to first coat of internal plaster), mixed with a small quantity of Portland cement, the finishing coat ditto, having an increased quantity of cement added, together with clean-washed gravel.

Work on walls is roughed in with four parts of same to one part of Portland cement, finished when dry with clean gravel (size of peas), mixed with cement in the proportion of two parts of gravel to one of Portland cement, mixed up in a bucket and thrown on when soft.

Small broken washed coke, pulverized stone, or any other sharp, clean material is suitable for providing the rough surface.

Rough cast is generally after colored with fast wash, which is sold for the purpose.

Internal Cementing is carried out much in the same way as external work, save that the finish required is of a finer character. Work such as bathroom dadoes, finishing of concrete floors, wall surfaces to dairies, wash-houses, and similar apartments, often require to be smooth rendered in cement. The finest finish is obtained by sprinkling the final coat with neat cement and trowelling with steel trowel to produce a glass face.

The junction of cement with plaster on walls may be finished with a sunk bead in cement.

In cement floors wood skirtings are best avoided, a more sanitary finish being obtained by hollowing round the angles and bringing up fair to wall surfaces.

CHAPTER XXI.

PAINTING, POLISHING, GLAZING, DECORATING, PAPER-HANGING, AND MAINTAINING.

PAINTING.

THE object of painting is primarily to preserve the material painted. In its higher developments its object is decorative—to create pleasing color surface and decorative form.

In modern work the painter's and decorator's craft is closely associated with the finish, not only of the ordinary wood and iron work and with the distempering of wall surfaces, but has to do with the color decoration of specially manufactured materials, such as fibrous plaster, stamped zinc, embossed pulps, and the very many other decorative surface coverings that enter into modern building.

Wall papers, too, are now so admirably produced that their selection and hanging enters very extensively into a very large section of general house decoration; while for public buildings the highest forms of handicraft decorative painting will ever have some need.

PAINTING ON WOODWORK.—In the preservation of timber painting enters very largely, supplying, as it does, an impervious surface to protect it from the action of wear and weather.

Unpainted Timber.—Certain timbers, such as those used in outside fencing, and to bush houses, where roughly cut native timbers are used, may be left unpainted.

Oiling and Painting.—Such timbers as jarrah, red Californian pine (redwood), stand well outside if thoroughly oiled, thus preserving in a degree their natural texture, grain, and color.

The imported pine timbers, however, require painting, especially deal, which is unsightly, on account of knots, and, being comparatively soft in nature, requires good, hard bodying to bring it to a workable and lasting surface finish.

Leads and Zinc.—To obtain a pure white lead is of the highest importance in painting, as this material supplies the body of nearly all good paints. Red lead and zinc-white are also used in limited quantity for certain classes of work.

White Lead Tests.—White lead for painting is readily discernible from whiting and other common substitutes by its excessive weight.

White lead should be stock lead of some well-known corroder's brand containing at least 25 per cent. of hydrate of lead in combination with sulphate and pure carbonate of lead.

Zinc White.—Zinc white is thinner than white lead, and tends more to "blue whiteness" rather than to "yellow whiteness." It is useful where a lasting pure white is required, as it is not so liable to turn yellow as white lead. It is, however, somewhat lacking in body.

Thinners.—Leads and zincs are thinned and made workable by the admixture of raw and boiled linseed oil and turpentine, to which is added certain drying substances, such as liquid terebene or patent driers.

Coloring Pigments.—The coloring pigments are now generally supplied by purchasable pigments ground ready for use in oil or turps. These may readily be blended and mixed with lead, and so any desired tint obtained with a greater degree of fineness than the old-fashioned, hand-ground pigments.

Driers are used to hasten the drying of oil paints. Those in common use are "terebene," a thin liquid used for quick-drying work; "patent driers," for ordinary slow drying of good work; "sugar of lead," for delicate shades such as white, greys, lakes, ultramarine blues, emerald green, or any color likely to be injured in purity of tone by the addition of foreign matter.

Varnishes are also used as driers, as also gold size, for certain classes of work. It has also to be remembered that both raw and boiled linseed oils have drying qualities in themselves.

Time.—It is highly important that painting should have ample time to dry, one coat being allowed three full days to harden before the other is put on, and the surfaces preserved from dust, and specially as far as possible from direct sun, which causes oil paints to blister, especially where an excess of boiled oil is used.

Formula for Ordinary Painting.—*Painting on Ordinary Woodwork.*—

Knots. —After all wood has been hand-dressed, and if necessary glass-papered and dusted down, coat over all knots with patent liquid knotting, to prevent them from showing through the work.

Priming.—Afterwards coat with a primer consisting of red lead, a very small quantity of white lead, raw linseed oil, and driers. This forms a hard surface for subsequent coats.

Stopping.—After the priming coat stop all nail-holes, cracks, or defects with putty (whiting and oil) and rub down.

Second Coat (Outside).—White lead, linseed oil, and sufficient driers, and pigment to tint.

Third Coat (Outside).—Ditto.

Fourth Coat (Outside).—Ditto, or a small quantity of boiled oil may be used.

Note.—It is not advisable to use much boiled oil with white lead colors, but it is necessary for earth or dark colors, with turps, so as to secure a hard surface.

Inside Work.—For inside work the above follows, save that turps are best, in a degree, substituted for the oil, as the turps produces a less oily, hard, and dull finish.

Rubbing Down. Rub down to an even surface with glass paper every coat with the exception of the final coat. This destroys all brush marks and inequalities of surface and brings the final coat to

a good even finish. At least three days should elapse between the putting on of each coat, as every coat must be thoroughly hard before the next is applied.

Flatting.—Interior woodwork is sometimes finished in "flat"—*i.e.*, with a non-shining, mat surface. This is not so wearable as a shiny oil finish, but has a pleasing appearance, and may be used for work removed from personal contact.

Flatting is done with turps as a thinner, with a very small quantity of oil or varnish, liquid driers being sometimes added for hurried work. Flatting should be finished with a stippling brush (a large, shallow, even-surfaced brush), which is dabbed over the work to destroy the ordinary brush marks.

Preparing Redwood.—Ordinary paint will not readily take on redwood. This wood should, therefore, be first coated with a wash of weak lime-water preparatory to receiving the priming coat.

Hard Body Finish.—In important work requiring high body finish, the work must be prepared by several successive coats of "coach" or other filling (a paste in turps laid on with a brush), thinned with gold size. When dry the surface is ground down with pumice stone or pumice powder and sandpaper, before the finishing coats of ordinary paint are put on.

An improved method of dealing with body finish is to make a filling of one-third each of white lead, paste, and turps thinned with gold size. With this filling the work is coated 6 or 8 times, finally receiving a coat of "stainers"—*i.e.*, Indian red and turps—which dries in a few minutes. The work is then ground down, the "stainers" enabling the workman to at once detect inequalities of surface. The first coat of paint upon the filling should be in hard drying color, with half turps and half oil and driers. This will firmly adhere, and form a hard surface upon which to lay subsequent coats.

Color Choosing.—In choosing color for outside work it must be remembered that the more lead body material the paint

contains the better for its lasting qualities. This brings in the desirability of using light colors, if preservation of service be the chief consideration, as the bulk of body can then be very much greater than in dark colors, such as bronze green, in which the body has to be confined entirely or almost entirely to powdered color.

Where dark colors are used they are best preserved under coats of the very best copal varnish, often renewed.

One coat of paint should in tone always lead towards the next, and so gradually towards the final, which should be brought to true tone complete in itself. A rule is sometimes adopted of coating in all work for the first two coats in uniform tint. The final colors are then decided, and the subsequent coats brought forward in "party tints" (various tints). This is some check upon the number of coats actually put on.

Painting on Cement.—Cement buildings are often after a few years painted in oil paint. This class of work requires a good priming coat to stop the excessive suction and to form a hard body. This is best secured by red lead and raw oil as a primer, subsequent coats being mixed as for ordinary work with a little boiled oil to dry hard to a durable finish. Oil paints will not adhere well on new cement work.

Painting New Plaster Work.—There is always risk in painting new plastered surfaces, partly owing to moisture, but specially to the activity of the lime, which eats out any color put upon it; for these reasons newly plastered surfaces are generally left uncoated for a year or two, when they may be painted, papered, or decorated with safety.

Should, however, this class of work be attempted, the surfaces must be coated with petrifying liquid or knotting previous to painting.

Lime Whiting is done with a mixture of lime, water,

and salt, and is useful as a clean, sanitary coating for common work.

Distempering.—Common distemper is made with whiting, size, and colors ground in water and laid on with flat brushes. Distempering is used for coating all classes of inside surfaces other than woodwork, such as plastered walls, ceilings, &c.

There are a very large number of powdered distempers upon the market that only require the addition of water to make them ready for use. Many of these are washable—*i.e.*, they may be afterwards sponged down lightly with a sponge and water. Some of these distempers are also specially manufactured to withstand the active effect of lime on new plastered surfaces.

Outside Water Coloring.—Outside cement dressings, rough cast, &c., may be colored in water paint. This consists chiefly of a mixture of lime, coloring matter, and a fixer such as copperas or salt. There are, however, several good paints for this class of work in varying shades purchasable in the market.

Coating Roof Coverings.—Iron roofing is often coated with non-conducting paint. This is best done with material of some well-known brand laid on in two-coat work ; or a substitute may be made with lime, salt, and sugar.

Where colors are required there are now paints specially manufactured for the purpose.

Painting Metals.—All metals subject to excessive oxidization require to be protected from decay and have to be periodically painted. Of this class is all constructional steel or iron work. This is best coated with a solution of red oxide of iron which has a chemical affinity for metal and is better for the purpose than lead paint.

Wrought iron may be painted in Berlin black to give a dull black finish.

All iron near heat, such as stoves, grates, iron stack pipes, &c., should be painted in Brunswick black thinned with turps.

Spouting, down pipes, verandah iron, and similar sheet metal work may be painted two coats in white lead colors mixed with gold size and turps (no oil). As this class of work is without suction ordinary oil paint would peel off.

For good work a hard, durable finish may be secured by the addition of varnish in thin coats.

POLISHING.

High-class internal woodwork lends itself specially to polishing, which is a process designed to preserve the surface of the wood, and at the same time accentuate the figure and grain by a semi-transparent, preservative covering.

Polishing is of two kinds—"wax polishing" and "French polishing." Side by side with polishing comes the question of "staining," and it may be laid down as an experience of practice that nearly all woods require staining more or less before they are polished, to bring them up to something like uniformity of tone throughout. Some parts are lighter or some denser in texture than other parts, and these require to be levelled up, while for certain classes of work the entire surface may require staining before polishing is applied.

The timbers that lend themselves specially to polishing are the hard fancy woods, of rich figure and dense structure, such as blackwood, boligum, beanwood, oak, and walnut, also cedar, rosewood, Huon pine, &c.

For cheaper kinds of stained and polished work New Zealand kauri can hardly be surpassed, while Queensland hoop pine is also good.

There are three chief kinds of stains—viz., water stain, oil stain, and spirit stain.

Anilines, darkeners, and fumigants, and specially manufactured stains of various kinds, are also employed.

Water Stain consists of coloring pulp, ground in water, and applied with a rag. This raises the grain somewhat, consequently when dry the surface is rubbed over with sandpaper before the polish is laid on.

Oil Stain is pigment ground in oil. This is more in the nature of painting, and is only used in inferior work.

Spirit Stain is pigment mixed with methylated spirit, and is generally applied with a brush. This stain dries immediately, and may be polished over at once.

Anilines are now used for staining, and there is also a large variety of manufactured stains upon the market, which require to be used according to directions.

Darkeners. –To darken cedar or other reddish woods, bichromate of potassium in water is commonly used. Washing soda and water also darkens such woods as oak, walnut, and cedar. These are transparent darkeners, and do not blind the wood.

Fuming.—Oak as a timber lends itself specially to toning by fuming. This is done by subjecting the wood to the fumes of liquid ammonia, either in a closed apartment or in an air-tight fume box constructed for the purpose.

Wax Polishing is specially suitable for large surfaces, and consists in coating the wood with an emulsion of beeswax melted in spirits of turpentine, applied warm with linen rags, and well rubbed. When one coat is thoroughly dry another coat may be put on, and the process repeated until the necessary surface is obtained.

For "dull" waxing three or four coats are necessary, whilst "bright" waxing often requires seven or eight to produce a good result.

Great care is required in waxing not to work up the undercoat.

French Polishing.—Polish is made of orange shellac dissolved in methylated spirit. This should be placed in an air-tight glass or earthenware vessel (not metal), and taken out in small quantities as required for use.

Most woods to be French polished require to be "filled" to produce a level surface for the polish to work upon.

Filling paste is made of plaster of paris mixed with pigment to match color of wood, ground in water, and applied to the work, which, when dry, is oiled over with raw linseed oil, and afterwards sandpapered down, and the polish applied.

The polish is laid on with rubbers consisting of flannel or wadding pads covered over with linen; with these the surface is worked over, a touch of raw oil being from time to time applied to the rubber with the finger, so as to make the polish work, and produce "dull shine." If "bright shine" is required spirits of wine is used on the rubber.

GLAZING.

Glazing consists in fitting glass to windows, doors, roof lights, &c. For these purposes a great variety of glass is manufactured, both clear and obscured, and specially made for various purposes.

Clear Sheet Glass.—The glass most commonly used for general window glazing is clear sheet glass, either 16, 21, or 26 ozs. per ft. super. This should always be of the best quality, as inferior glass is liable to be wavy and uneven, and to give a distorted image when looked through.

Clear sheet glass is made in a large number of different sizes, and is cut with a diamond to sizes required. The usual outside limit of size of imported English sheet glass is 50-in. by 36-in. for 16-oz., 60-in. by 44-in. for 21-oz., and 72-in. by 48-in. and 70-in. by 52-in. for 26-oz.

Sheet glass is usually fixed by being bedded in putty (whiting ground in oil) within the rebate of the sash, sprigged in to keep it in position, and over-puttied and smoothed off outside with a splayed surface. This is called "glazing sashes."

Plate Glass.—Plate glass is thicker than sheet glass, and made in very large sheets. When of British polished plate quality it may be relied upon to give a true image when looked through, and is

used for the glazing of large windows, and especially shop windows, and show cases. In fixing plate glass the edges should be blackened to prevent glistening, and the glass kept in position with beads or slips.

Plate glass may be bent to shapes and curves for special work, such as bow windows. This is done in specially-made furnaces.

Leaded and Stained Glass.—Leaded glass is a common term applied to glass-work set in lead bars. These bars are made up of double-channelled flexible lead strips manufactured for the purpose, cut to shape and soldered up and strengthened by having rigid wrought-iron cross bars copper-wired on to stiffen them when placed in the opening they are designed to occupy.

Leaded glass may be glazed in clear sheet glass in rectangular panes or glazed partially or wholly with colored glass manufactured for the purpose, such as cathedral, Venetian, antique glass, &c. These colored glasses are made in a very great variety of colors and textures, and, with certain specially-shaped accessories such as roundels, jewels, &c., are designed in patterns and leaded up to suit various positions, the glasses being closed into the leads with waterproof mastic.

This class of work is largely used in domestic architecture, and shows the continuation of one of the old crafts, very specially identified with ecclesiastical window treatment.

In its higher branches "stained glass," as it is called, deals with conventional pictorial representation of scenes and incidents, and becomes, by its adoption, a permanent, transparent pictorial art.

There are two manners adopted in colored work of this kind, one in which the colors are alone obtained by choosing and glazing the various pieces in such a way as to obtain the result direct from the glass chosen, and the other is obtained by painting and burning in certain portions of the glass to give the necessary details of the minor parts. This latter is mostly applied to intricate figure work, such as in church or memorial windows.

Leaded glass, when in woodwork, is fixed with wood beads; when

in stonework a channel (a raglet) is cut out to receive it, and the lead is pinned in with cement mortar.

Roof Light Glazing.—Roof lights are usually glazed with specially heavy, and generally with obscured glass, such as "rough rolled plate." This, if upon the top slopes, is best fixed, not with putty, which readily decays, but with metal glazing bars made for the purpose.

"Wired plate glass" is another kind of glass for this purpose. This consists of wire netting bedded within the centre of the glass. The advantage of this is that should the glass be broken the fragments will not fall in large pieces so as to cause danger below.

Fancy and Special Glass.—Of fancy glasses there are a large number, both in color and with embossed patterns upon them. Obscure and ground glass may be used where a thin obscured glass is required.

Muranese glass is a much-used type of fancy glass manufactured in white and color. This consists of a thick glass with a small raised pattern upon it which glistens and reflects in a pleasing manner when under the influence of light. This is also an obscure glass, and is useful for all kinds of purposes, in screens, doors, and the upper parts of windows, &c.

Fancy glasses are usually fixed in beads, though thin embossed glasses, being smooth-faced, are sometimes sprigged in and puttied.

For certain special purposes plate glass may be treated with acid, and brought out in pattern or lettering, as required, by making certain portions of the surface dull and other parts light, or this class of work may be applied to mirror-backed glass.

In addition to the above there are a large number of glasses manufactured for special purposes, such as prismatic glass, to reflect light in confined and cramped areas; clear ribbed glass, to give the maximum of light with obscurity, and many others.

Pavement and Stallboard Lights.—To give light to basements stallboard lights are used. These are usually arranged between

the sill of the ground floor windows and the pavement or ground, and consist usually of metal frames filled in with specially-made prismatic glasses.

Area pavement lights are also made in a similar way, and fitted with heavy lenses, so designed as to receive the light from above and throw it horizontally into the basement apartments. Such glasses should be set in elastic mastic, otherwise the contraction of the metal frame tends to break the glass.

DECORATING.

Decorating is a skilled craft which in its higher branches merges into a fine art.

The work of the decorator goes further than the work of the ordinary painter, and extends from plain painting in oil or water color to the high finish of applied pictorial art.

Decorating in Water Color.—Decorative work on walls and ceilings is often carried out in distemper colors—*i.e.*, with colors ground in water (see Painting). This class of work produces clean, even, flat (non-shining) surface, which may be elaborated with ornamental work to a very high state of decorative finish.

Stencilling.—Repeat patterns, such as dadoes, friezes, centres, cornices, &c., are produced by stencilling. Stencils are made of stout cartridge paper, through which the pattern is cut, the paper being rendered impervious by coating with patent knotting. Color is then laid over the stencil in position, and produced on the work in the required tints.

Stencilling is sometimes done without color, in pure varnish only. This gives a shiny "damask" effect.

Lining.—Lining is produced by the aid of rules and pencil brushes.

Decorating in Oil Color.—Decorative painting in oil is generally finished in "flat." If upon plastered surfaces, the suction should be stopped and the surface made fair before the oil painting is started. This may be done by coating with two or three coats of

water distemper (whiting and size), well rubbed down with flat pieces of wood covered with glass paper, dusted down with dusting brush, and tested all ways with 6-ft. straight edge to avoid inequalities. This prepares the surface for oil painting, which may be in four-coat work—first coat of white lead, half raw oil, half turps, with varnish as driers; second and third coats ditto; fourth coat with turps, only very little varnish as driers, finished with stippling brush.

Bulk colors are generally used in the backgrounds or plain surfaces, and fine tube colors for decorative tinting.

Decorating on Fibre.—For painting on fibrous plaster or similar material such work as flowers, devices, or figures, the surface may be prepared by a first coat of varnish, second coated with white lead, turps, and a touch of varnish, the finished painting being executed with tube colors thinned with turps.

Decorating Metal Ceilings.—In decorating on embossed metal two thin coats only are necessary, consisting of white lead, raw oil, varnish (as drier), thinned with turps, finished in a third coat of flatting.

Pictorial Painting on Canvas.—High-class figure work may be painted on canvas, and afterwards applied directly to plastered walls or ceilings with a mastic of white lead and venus turpentine, the canvas being pressed from centre outwards with flat rules until the whole surface completely adheres to plaster, when edges may be covered with moldings.

Gilding is best done with gold leaf, gold size being used as an adhesive for immediate work. More lustre is obtained if slow-drying oil size is used and the work allowed to stand for twenty-four hours before the gold is applied.

Parts requiring to be burnished are rubbed with an agate polisher; dulled parts are coated with parchment size.

For cheap work, silver and gold and other bronzes are in many cases used as substitutes. These are purchasable ready for use, and applied in liquid form.

Cleaning Down.—In cleaning down internal decorative work before scaffolding is struck, a good plan is to coat the whole of the work with beeswax and turpentine, laid on with large brushes followed with "stipplers." This gives to the surface an even, soft, and pleasing effect.

Graining and Marbling.—Graining is the imitation by means of paint of certain decorative woods, marbling being the imitation of stone. This class of work is always under varnish, and requires high executive skill; it is, however, so personal that no definite rules may here be laid down for its execution.

STAINING AND VARNISHING.—Only certain finishing woods are suitable for staining, and these must be carefully selected for the work. Woods that differ in density in various parts are always the most difficult to successfully stain, as the color sinking in more in certain parts than in others tends to patchiness. This often leads the workman to "paint" rather than "stain" the work, a mode of procedure that is to be strictly avoided.

Ready-mixed stains are now best used. These may be obtained in water, spirit, or oil. Stains are brushed on in one or more coats, and fixed with polish or varnish.

Although size water is commonly used in staining and varnishing, its use is mostly directed to the saving of material, and, unless mixed in thin solution and allowed to thoroughly dry before over varnishing, serious results are sure to follow. Much of the trouble caused by non-drying varnish work is traceable to the use of size, such work often remaining "tackey" for many years.

Varnishing.—In selecting varnish, only that manufactured by well-known makers and bearing standard brands should be employed. Varnish should not be used in excessively cold weather, as the material congeals. There are many kinds of varnish, some suitable for outside, others specially for inside work. Varnishes are known as copal, carriage, church oak, encaustic, spirit, &c., according to their character and quality.

In varnishing hand-dressed woodwork without staining, coat with varnish directly on to the work till the desired surface is obtained. This gives the best possible results.

For varnishing over staining, two coats at least are required, one being dry and hard before the other is put on, and the whole kept free from dust and insects, each coat (save the last) being rubbed down with glass paper.

For outside work, such as doors, window frames, &c., oak varnish may be used. Copal is used over delicate colors, either outside or inside. For such work as seating, furniture, fittings, &c., church oak varnish is employed.

Encaustic varnish is a high-priced varnish that dries with a dull, egg-shell finish, which looks well for high-class work, and may be used to contrast (as in panelling) with high gloss varnishes.

Spirit varnish is used for hurried work, as it dries almost instantaneously. It is, however, not so durable as other varnishes.

PAPERHANGING.

Paperhanging is the craft of hanging walls and ceilings with papers, embossed pulps, &c., manufactured for the purpose.

All surfaces to be papered should be quite smooth, especially where plain-surfaced papers are to be hung. All cracks and holes should be filled with plaster of paris, the surfaces rubbed down and coated with size water to stop suction.

Wall papers are imported in rolls.

English papers are mostly used, others being imported from America, Germany, and France.

The standard size of English wall paper is by the piece, 21 in. wide and 12 yds. long, and it may be taken as a safe working rule that, measuring an apartment over ordinary openings, and allowing for matching of pattern and waste, such a roll of paper will cover 60 ft. super.

The following table may be used for reference :—

PAPERHANGER'S TABLE for Calculating the Number of Pieces of English Paper required to Paper an Apartment of any given size.

Measure round the Walls in Feet, *including* Doors, Windows, &c.

Height in feet.	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100 ft. round Apartment.
From 7 to 7½ ft. ..	4	4	5	5	6	6	7	7	8	8	9	9	9	10	10	11	11	12	12 Pieces of Paper
,, 7½ to 8 ft. ..	4	4	5	5	6	6	7	8	8	9	9	10	10	11	11	12	12	13	13 ,, ,,
,, 8 to 8½ ft. ..	4	5	5	6	6	7	7	8	8	9	9	10	10	11	12	12	13	13	14 ,, ,,
,, 8½ to 9 ft. ..	4	5	5	6	7	7	8	8	9	9	10	11	11	12	12	13	13	14	14 ,, ,,
,, 9 to 9½ ft. ..	4	5	6	6	7	7	8	9	9	10	10	11	12	12	13	13	14	15	15 ,, ,,
,, 9½ to 10 ft. ..	5	5	6	7	7	8	9	9	10	10	11	12	12	13	14	14	15	15	16 ,, ,,
,, 10 to 10½ ft. ..	5	5	6	7	8	8	9	10	10	11	12	12	13	14	14	15	16	16	17 ,, ,,
,, 10½ to 11 ft. ..	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	16	16	17	18 ,, ,,
,, 11 to 11½ ft. ..	5	6	7	8	8	9	10	10	11	12	13	13	14	15	16	16	17	18	18 ,, ,,

The following are the standard sizes of English, American, German, and French papers :—

	Width.	Length.
English	21 in. by	12 yds.
American	18 in. by	16 yds.
Do. ingrains (*i.e.*, without pattern) ..	30 in. by	16 yds.
German	18 in. by	12 yds.
French	18 in. by	8½ yds.

Papers are manufactured for certain special purposes, such as fillings, dadoes, friezes, and ceilings.

Friezes and Bands are sold at per yard, and are of differing widths, from 5 in. to 21 in.; common stock sizes being 10 in., 15 in., 18 in., and 21 in.

Trimming.—Papers are made with a narrow superfluous margin, which has to be cut off and the paper "trimmed" to a sharp edge to match. This is done either by machine or scissors. The object of this margin is to protect the paper from damage in transit, and to give space for a true join to be made.

Ordinary paper may be secured with strong flour paste. Embossed pulps and heavy papers require thin Russian glue or paste and glue.

Paste and Fixatives.—Paste should be made in a clean vessel, by mixing flour with luke-warm water into a smooth paste, free from lumps. Over this boiling water is poured, and the whole brought to a proper consistency. A little borax will prevent paste from turning sour. Alum may be added as a fixer.

Actual Papering. — *Walls.*—After trimming, cutting, and pasting, wall paper is hung in position by testing the first piece with a plumb line, starting from the top edge and brushing the paper down with a large brush or roller. The next piece is then laid to match, and the process repeated round the room, all edges being well rolled down with small roller, so as to make them invisible, and top and bottom edges neatly cut and fitted.

If a pattern paper is being hung, the pattern should so divide as to be alike at top and bottom.

Ceilings.—In papering ceilings, the laying should be done from centre of apartment, so that the pattern may work out alike at all edges and corners.

Friezes and Bands.—Horizontal papering, such as with friezes or bands, should also be laid from centres, so that internal angles may work out to match.

Heavy Coverings.—Embossed pulps and heavy papers often require to be thoroughly back soaked with stickative before being laid. These should be pasted and allowed to stand for a time before being hung. On ceilings heavy pulps may require to be temporarily secured with tacks while stickative is drying.

Decorating and Varnishing.—Embossed pulps are usually decorated either in flat oils or distemper coloring, and may be picked out in gilding or special colors. Where varnishing is done on paper it should be twice sized and twice varnished with copal or carriage varnish.

MAINTAINING.

Property owners require to write down a certain sum of money per year for " maintenance," and this ultimate question of cost of maintenance should have due weight when the property is being built.

How will it last? How will it wear? How will it appear in ten years' time? are all questions that may well be asked and their reasonable answers allowed for in the building.

A soundly constructed building will, in some degree, improve with age, for there will always come with the passing of years the mellowing toning down of outside surfaces, which, at the first, are necessarily somewhat crude and new. It may be taken as a rule that good honest work will mellow well and look better with age, whereas shoddy and makeshift building will go to pieces.

But while it is true that this mellowing goes on, it is also true

that all the elements are, year by year, going back to their original dust. Wood shrinks and rots, iron rusts and decays, paint perishes, and wear and tear destroys, until the whole structure calls for the diligent hand of the repairer.

Legitimate and necessary repairing may always be separated from natural weathering, for time alone can impart a certain quality of charm not obtainable in any other way—a charm commented upon again and again by travellers among the Old World buildings.

This natural weathering is therefore to be prized, and if it be upon honest, sound walls and roofs, should be preserved rather than cleaned off, to make a building look what it may not look "new again."

For this reason, artificial colorings, tuckpointing, and temporary shams have only their very little day—a few years, in some cases a few months, lay them bare, and reveal a far worse state of appearance than if they had never been.

The lowered tone of stonework, the less garish surface of old brickwork, the green and brown colorings of tiled roofs, the grey silverings of our fences and natural timberings, the dulness of old metal may all well be left alone.

In overhauling a building, therefore, repairing should be done with discretion, and in such a way as to preserve rather than to destroy the general character of the original work.

The Preservation of Walls.—Both brick and stone walls often require to be repaired from the action of damp, either from surface driving rains or defective damp courses. Many of the outer walls of our older buildings have been built solid, and give, in consequence, continual trouble through dampness on the weather side. Such walls may be allowed to dry out and then be well coated with petrifying liquid, or painted in oil, or cemented and painted.

New damp courses are best formed of sheet lead inserted through the thickness of all walls, under ground floor timbers or just above the ground.

Worn jointing may be repaired by raking out mortar and stopping in and pointing in cement. Creeping plants are best removed from walls on the damp weather side of buildings, especially those that are, by their nature, leaf-covered all the year round.

OVERHAULING ROOFS.—*Structure.*—The structural parts of roofs should be periodically overhauled, and for this reason all roof spaces should be made accessible from inside by trap doors, and walking over boards laid on ceiling.

However well constructed a roof may be, there is always the inevitable settling down of timbers, shrinkage, and saggings, which by slight attention may often be made right. In large roofs the readjustment and tightening up of ties, jibs, bolts, &c., is also often desirable and necessary.

Such overhauling gives opportunity to examine all pipes, wires, tubes, &c., that may have their runs in the roof space.

Coverings.—The outer coverings of roofs, and especially internal gutters, need careful attention. All gutters and spoutings should be cleaned out, free from dust or leaf deposit, and all storm water runs made clear and free.

A judicious use of solder, where galvanized iron shows signs of rusting, will do much for its preservation, while the tightening up of all screws used in corrugated iron roofing or sheet-iron spouting will add to its stability.

Roof tiles, if cracked or broken, should be replaced with new, and all pointings overlooked and renewed; also flashings should be looked to, and kept down from updriving winds.

Should tiles require to be cleaned from discoloration this may be done with diluted muriatic acid, scrubbed on with stiff brushes and afterwards washed with clean water.

Slate roofs are on the whole more liable to breakages than tiled roofs and need to be very carefully repaired lest more damage be done in the repairing. For this work special roof ladders, from

which the workmen may reach and make good broken or damaged slates, are necessary.

Slates are sometimes damaged by excessive changes of temperature or by very heavy local storms. The friction of the slates against the nails, due to the wind, is also a common cause of disrepair and displacement, as also is the juvenile habit of stone-throwing, which tends to damage this type of roof more than any other.

Floors.—Wood floors, and especially ground floors, are liable to rot through the lack of ventilation. These should be overhauled, and especially ground floors where moisture, as well as lack of air, may quickly cause serious decay, not only of the boarding but of the structural supporting timbers. To all these free currents of dry air should be given and the cause of any dampness removed.

Shrinkages.—Even if well constructed, new work will, in the first year or two, often shows signs of shrinkage, the very great difficulty, so constantly experienced, of obtaining highly-seasoned timber, especially for finishings, being made manifest as the work settles down. Again, with inside plastered timber frame houses, and especially at the junction of wood with brick, such as at chimneys, fracture is almost certain to occur. These and other like defects require to be made good, and should enter into the legitimate work of maintenance.

Sanitary Fittings.—In addition to the usual domestic cleanliness of sanitary fittings and waste water drains, such apparatus should be periodically overhauled, both for cleansing and testing, and if necessary repainted.

Only skilled workmen are competent to do this—to take apart the various cleaning screws from taps, &c., to remove corrosion or rust, to empty grease traps, and to test and clear vents, cowls, wastes, and drains, and to flush out all pipes and channels with powerful disinfectants, such as dilute carbolic or permanganate of potash.

PAINTING, &c.—*Painting* must always enter largely into the maintenance of a building, especially where the work is outside and exposed to severe heat and destructive weather.

For old outside painted surfaces, blistered and uneven by wear, the old paint should be flame burnt off, and clean scraped right down to the original surface. Painting should then be done as to new work (see Painting).

All ordinary painted surfaces to be repainted should first be well cleaned down, inequalities ground down with pumice and glass paper, and all cracks and defects stopped with putty.

PAPERHANGING, &c. — Paperhanging and general internal decorating is, in most cases, carried out some time after the first occupancy of a building, when the soiling of the plaster surfaces calls for covering and repair.

Where papering is done on walls previously papered, the old paper should be soaked with water and removed, walls stopped and repaired and sized before new paper is hung.

OLD DISTEMPERED SURFACES.—Old distemper must also be thoroughly washed off before re-coating is laid on.

CHAPTER XXII.

SPECIFICATION WRITING AND QUANTITY TAKING.

Specification Writing.—A specification (or speç, as it is commonly called) is a detailed, written description of the work to be carried out in a building, and is a document designed to supplement the information shown upon the working and detail drawings, and as such is made to form a part of the building contract.

No specification can be said to be a good specification unless it is at once practical and concise. Dealing, as it must, with very practical things, and being a guide for the carrying out of actual work, very complete and experienced technical knowledge is required in specification writing, otherwise the descriptions may not only prove misleading, but, if not workable, absolutely ridiculous.

The pre-eminent requisite of the specification writer is "knowledge"—practical knowledge of the carrying out of building works.

Many attempts are constantly being made, even among architectural practitioners, to create "model" specifications to save the exacting labor of writing speçs for each new job, but such models invariably prove unsatisfactory, as every job differs, and, even though similarity may exist, differences of site, aspect, and minor parts may involve the speç in error. It will, therefore, in practice be found that every job requires its own speç and its own interpretation.

A speç, be it remembered, is in a marked degree first of all a document of reference, and as such should be so written that any part may be readily found and referred to. It is also a document

describing the work of separate trades, and for these reasons should be particularly well ordered in grouping, well indexed, and the whole divided into separate "trades."

Some difference of opinion exists as to the actual grouping and sequence of the various trades, but a safe guide may be indicated by placing a "trade" as near as possible in the position it will occupy in the actual carrying out of the work. For example, "bricklayer" will come before "carpenter," and the roof will be covered in before the walls are plastered, while the "joiner's work" will be fitted in towards the completion of the structural work, and "painting" will be at the very last. In the speç, therefore, of an ordinary brick job, some grouping of trades may be made as follows :—

Index, Generally, Excavator, Concretor, Mason, Bricklayer, Carpenter and Joiner, Smith and Founder, Ventilation (in all trades), Plasterer, Plumber, Tiler, Glazier, Electrician, Gasfitter, Bellhanger, Painter.

For an ordinary timber residence the grouping would work out somewhat as follows :—

Index, Generally, Excavator, Bricklayer (for chimneys), Carpenter and Joiner, Ventilation (in all trades), Plasterer, Plumber, Glazier, Gasfitter, &c., Painter.

For all practical purposes a speç is best first drafted on speç foolscap paper and afterwards type-written in duplicate. This method allows of the draft being fully corrected before the fair copies are made, and if properly carried out should leave the final copies perfect and free from all corrections ; it also facilitates the making of correct duplicate copies, for usually two or more copies of the speç are required for a contract.

Foolscap-sized ruled paper with $1\frac{3}{4}$-in. left-hand side margin is best for drafting upon. This side margin is very important, as it gives opportunity for every paragraph to be indexed, so that by running the finger down the page any item in a "trade" may readily be picked up.

The size of paper used for typing is a matter of opinion, but whatever the size adopted the side margins should be clearly kept as in the draft, and each trade commenced on a new page. This is useful for sub-contracting, the work of any trade being clearly defined and complete in itself.

Binding up the final speç in book form with a flexible linen cover and with the title lettered on the outside has much to recommend it, especially when it is remembered what a considerable amount of rough wear and tear a speç has to sustain in a job extending over a lengthened period. For this reason, also, the paper used should always be tough and strong.

Top pinning or sewing is sometimes adopted, and allows for rolling up the short way for pocket carrying, the top left corner pinning being the most convenient. This, however, leaves the edges of the three remaining corners very much exposed to damage.

The index should be upon the first page of the speç, and the folio number at the commencement of each division or trade should be clearly given, such, for example, as "Bricklayer, folio 15." This enables any trade to be found at once.

In writing speçs it is important that quiet be secured, and if the drawings be so pinned up or arranged around so as to be seen together at a glance, without overlapping, so much the better.

Speçs should never be written without the drawings.

Some speç writers first prepare a complete list of items before commencing to write. Such a plan is a good one, and often obviates the danger of leaving out (an error very likely to occur). It further has the advantage of enabling the writer to lay down or take up the work at any point, the various items being marked off as they are specified.

To write a speç without notes requires a most complete knowledge and mastery of the work, especially to keep the items in proper sequence.

Neat marginal sketches are often of great value in speç writing, and should be freely used to amplify the text; their only dis-

advantage is the labor involved in duplication when copies have to be made.

In writing a speç a commencement should be made in "Generally" by giving all items common to the whole work, and in grouping, as far as possible, any general instruction at the beginning of the speç.

Each trade should deal with the work in its own trade, beginning with general clauses and materials, and proceeding to general descriptions relating to the trade, thence passing on to definite items of the work, commencing with the least important and working up to the most important.

SPEÇ FOR A COTTAGE.—As an example of actual specification writing, the following are the note headings required for a specification of the cottage illustrated in Chapter II., Plate III., to the working drawings of which reference should be made, so that the items may be followed :—

Following the notes the specification itself is given.

NOTES.—*Generally.*—Notices, materials and labor, insurance, clear site, conditions of contract, datum and setting out, provisional sum, note about position of existing outbuildings, prime costs.

Excavator and Concretor.—Digging, filling, rough asphalt, concrete, concrete floors.

Mason.—Stone thresholds, verandah curb, sills, slate shelves.

Bricklayer.—Bricks, mortar (lime), mortar (cement), method of work, building in fire-places, chimneys, &c., arches, lintels, vents (all trades).

Carpenter and Joiner.—Timber, &c., floors, roofs, louvred vent, eaves, gable, verandah, lobby door, inside doors, trap door, solid frame windows, box frame windows, window boards, architraves, skirtings, linings, chimney pieces, kitchen cupboards, sink top.

Plasterer.—Laths, stuff, method, angles, internal cementing, rough cast.

Plumber.—Valleys, spouting, down pipes, flashings, water, sanitary fittings, gas service.

Tiler.—Floor tiles, &c., roof tiling.

Painter.—Plain painting, flat, varnishing

Glazier.—Colored glass, clear leaded, sheet glass.

Specification of work to be done and materials to be used in the erection of a *Lodge Cottage at New Park* for the Hon. Templar Lowell. Under the direction of

MR. HARDWICKE MANTON,

Architect,

Of 29A Austral Crescent,

Traumland.

Final Note.—

GENERALLY.

Notices.—Give notices to municipal and other authorities. Comply with regulations and pay all fees.

Materials and Labor.—All materials used in the carrying out of these works to be the best of their several kinds, only the best and most skilled and approved labor being employed.

Insurance.—Insure the buildings in the name of the proprietor in an approved office to the full amount of contract, and lodge the receipt with the architect.

Clear Site.—Clear site from all obstructions, cut down and grub up all trees actually upon the area required for building, and take instructions and allow for the preservation of surrounding trees during the time the building is being carried on.

Conditions of Contract.—All building works to be executed in strict accordance with the working drawings, specification, the general conditions of contract issued by the Institute of Architects, and such other detail drawings as may from time to time be issued by the architect.

Datum and Setting Out.—The level of the finished floor line is called "datum." This will be fixed by the architect upon the site,

and all heights and depths are to be measured from it. The architect will also give a starting point from which the contractor will be required to fully and accurately set out the whole of the work in strict accordance with the drawings.

Provisional Sum.—Allow in tender the sum of £15 (fifteen pounds sterling) for contingencies to be used for extra works (if any) that may be ordered in writing by the architect or deducted in whole or part at completion.

Note.—Fencing, paths, &c., are excluded from this contract. Water is carried to a point 40 ft. from the proposed building. Workmen's W.C. and conveniences are also available.

The surface drainage must be conveyed to a point 30 ft. from the N.E. corner of the building, where it will connect with old drains.

Fuel store, laundry, W.C., &c., are allowed for in existing buildings.

Prices.—Prices quoted for goods, &c., are to be taken as ordinary trade prices delivered on works.

EXCAVATOR AND CONCRETOR.

Digging, &c.—Excavate all trenches to the full depths and widths shown upon the drawings, and to any greater depths which may be ordered by the architect. Such extra depths (if any) to be valued by the architect and paid for at current rates.

All trenches to be trimmed, levelled, stepped, and kept dry, and no concrete to be placed in them until they have been inspected and passed by the architect.

Excavate for gas and water services, surface drains, &c.

Fill in earth and well ram around foundations and where required. Keep space under floors free from *débris*. Wheel and spread superfluous earth near the site, and remove all rubbish that may from time to time accumulate as the work proceeds, and leave premises clean at completion.

Filling.—Fill in with dry, well-rammed earth under all tiled floor surfaces.

Asphalt.—Lay under all wooden floors, upon the natural surface of the ground, a 3-in. thick bed of dry, sharp, clean gravel, well rammed and top-coated with tar.

Concrete.—The concrete for foundations to be composed of three parts of 2-in. gauge hand-broken granite, one part of $\frac{3}{4}$-in. gauge granite screenings, two parts of clean, sharp, approved sand, one part of best Australian Portland cement of an approved brand. Concrete to be mixed upon clean wooden floor and materials measured in gauge boxes.

The material to be well turned over dry, gradually watered with fine spray watering; turned over twice wet, placed in trenches to the widths and depths shown and figured on drawings, well rammed, levelled off, and left to harden before brickwork is commenced.

Lay under all floors and hearth tiles a 4-in. thick bed of concrete gauged as above but with two parts of screenings and two parts of 2-in. granite.

MASON.

Stone.—All stone to be best Melbourne bluestone, rough punched on beds and joints, and patent fine axed on all exposed surfaces, set in cement mortar.

Thresholds.—The two outside doors to have thresholds 9 in. longer than openings, full width of wall and thickness equal to two courses of brickwork, holed at ends for iron dowels from door frames.

Verandah Curb.—Verandah curb to be 11 in. by $6\frac{1}{2}$ in., the front portion in four lengths and the side portion in one, ends dowelled together with 1-in. galvanized iron gas pipe.

Outside steps to be same as thresholds and of lengths shown. Back stair coping to be of $10\frac{1}{2}$-in. by 4-in. rounded on top bluestone.

Sills.—Window sills to be 13 in. by $6\frac{1}{2}$ in. by 9 in. longer than openings, having $\frac{3}{4}$ in. rebate to receive wood sills, and weathering therefrom to outside edge, with throating underneath beyond wall

Both sills and steps to be bedded at ends only, the intervening portion being left free and pointed up at end of contract.

Slate Shelves.—Pin into wall, and connect by joggles, three rows of $1\frac{1}{4}$-in. rubbed Mintaro slate shelves in pantry.

BRICKLAYER.

Bricks.—The first picked quality, machine made, steam pressed, and Hoffman kiln burnt bricks by an approved maker to be used.

Those for foundations to be specially hard. The outside faces to be of picked bricks of uniform color and good arrises.

Lime Mortar.—Sand for mortar to be thoroughly clean, water-washed creek sand, coarse, of good grit, and free from all earthy or vegetable matter.

Lime to be freshly burnt and of approved kind.

The lime for lime mortar to be slaked in a mixing box and run through a fine sieve, and mixed with sand in the proportion of one part of lime to two and a half of sand, well knocked up, and left in large heaps fourteen days before use.

Cement Mortar.—Cement mortar to have one part of Australian Portland cement of an approved brand to three parts of sand, always used fresh.

Method.—All foundations up to underside of ground floor plates to be built in cement mortar. All external walls to be hollow, with a $2\frac{1}{4}$-in. cavity, tied together every fourth course with wall ties consisting of No. 8 galvanized fencing wire, bent oval-wise, 9 in. long and 3 in. wide, laid across the cavity every 30 in. apart diagonally.

Allow also for lengths of galvanized hoop iron at window sill level throughout the work, one strand to each half brick in the thickness of all walls, lapped and rivetted at junctions, and turned up and down at ends into the work.

Carry up all the walls simultaneously with bricks set horizontal and plumb, every joint being well flushed up and grouted in quite solid with mortar. The outside joints to be finished with a ruled cut and down struck joint, and all perpends to be carefully kept. Carry up gable wall at back of half-timbering in 9-in. work in English bond.

Building In.—Allow for solidly building in all door and window frames, &c.

Fire-places, Chimneys, &c.—Build fire-places as shown. Those to "beds" 1 and 2 and "living" to be set with semicircular glazed brick arches, and the openings lined to height of 3 ft. 3 in. above floor with special bricks to match, all to be selected. Form brick hobs and dished back hearth with special fireclay bricks set in fireclay. Allow in tender the total sum of £10 (ten pounds sterling) for these special bricks, and fix same.

Form 14-in. wide jamb to these fire-places, and carry up from each a 9-in. by 9-in. flue, smooth rendered inside with stiff mortar and cowdung, gathered over to check down draught. Finish chimney-stacks to detail with two courses of selected molded bricks, with special-made external angles, all set in cement mortar. Set selected pot to each flue at 8s. each, and weather around in cement mortar. Leave top of stack for "plasterer."

The kitchen to have a selected range, for which allow the sum of £10 (ten pounds sterling), and fix and set same solidly according to directions, together with hot water boiler, flues, &c.

Carry opening at height of 4 ft. from floor upon a 3-in. by 2-in. R.S.J. and line 9 in. all round openings and all around visible parts at back of range with best Australian-made white-glazed bricks, those to jambs being bull-nosed.

Arches.—All external openings to have cut, rubbed, and gauged arches set with fine joints in cement and carried each on 2-in. by $\frac{1}{4}$-in. wrought-iron bars, turned up and down $4\frac{1}{2}$ in. at each end into the walling.

Lintels.—All openings to doors and windows inside and lintel in

passages to have coke concrete lintels, compounded of one part of cement to one part of sand and two parts of $\frac{3}{4}$-in. gauge coke washed free from dust. Each lintel to be full thickness of work, 9 in. longer than opening, and equal to three courses of brickwork in height.

Vents. –Take instructions from architect as to position of vents. Allow for leaving draught holes under floors in all internal walls for the free circulation of air.

Allow for and fix No. 8, 9-in. by 6-in. terra-cotta wall face vents in outside walls to ventilate under floors, with mouse-proof wire at back. Allow for a vent near ceiling through outer wall of each apartment having a 9-in. by 6-in. through cavity lined with a close boxing of 24-gauge galvanized sheet-iron, and fitted outside with 9-in. by 6-in. terra-cotta wall faces and on inside with metal valve vents and cords at 5s. 6d. each.

CARPENTER AND JOINER.

Timber, &c.—All timber used to be the best of its kind, sound and well seasoned and free from all defects, cut, secured, and fitted together in the best and most workmanlike manner.

All woodwork exposed to view to be hand wrought to one even, smooth surface throughout.

Floors.—Wood floors to have $4\frac{1}{2}$-in. by $1\frac{1}{2}$-in. jarrah plates and 5-in. by 3-in. jarrah bearers. Joists to be of 4-in. by 2-in. hardwood, spaced 18 in. apart centres, covered in kitchen with 4-in. by 1-in. T. and G. jarrah flooring, and in all other apartments with 6-in. by $1\frac{1}{8}$-in. T. and G. Queensland pine flooring, all well cramped up and well nailed with two oval nails to each intersection of joists well punched in. 4-in. wide mitred margins to hearths.

Roof.—Build the roof of Oregon timber, with the following scantlings :—Rafters 4-in. by 2-in., 18 in. apart centres, with 4-in. by $1\frac{1}{2}$-in. collar to each pair of rafters ; ridges, hips, and valleys 10-in. by $1\frac{1}{2}$-in. ; wall plates on outside of outer walls $4\frac{1}{2}$-in. by 3-in., on inside walls $4\frac{1}{2}$-in. by 1-in. ; ceiling joists 4-in. by 2-in. ;

bridge over centre of each room with 9-in. by 1½-in. hanging beam on edge, hung to each joist with 1½-in. by 1-in. fillets nailed to sides.

Trim around chimneys, &c., in timbers one inch thicker than other timbers. Valley boards 9-in. by 1 in.

Louvred Vent.—Form a louvred vent in roof where shown with redwood, having 5-in. by 4-in frame and weather sills, and 1-in. thick steeply set louvre blades, housed in and guarded at back with ¼-in. mesh galvanized bird wire. Carry out timbers to take barge 7 in. beyond frame, and line soffit with ½-in. thick T. and G. and beaded boarding, barge to be 9 in. by 1¼ in., with 3-in. by 1½-in. mold under tiles.

Eaves.—Eaves to be of redwood, cased in with 4-in. by ½-in. T. and G. and V-jointed soffit lining, and having 9-in. by 1-in. fascia, with 2-in. quarter round mold under spouting. Small quarter round in all angles.

Gable.—Plug walls of gable, and after first coat of plaster fix on surface framed-up half-timbering, consisting of 11-in. by 2-in. out beam, 5-in. by 2-in. uprights, and 7-in. by 2-in. rafter pieces, all framed and wood-pinned together. Carry out ridge, wall plates, also short 3-in. by 2-in. jacks, and carry 12-in. by 2-in. barge, with 3-in. by 2-in. mold under tiles. Line soffit same as eaves.

There will be a pair of 4½-in. by 3-in. framed-up brackets, with 4½-in. by 3-in. pieces built into walls. All to detail.

Verandah.—Carry general roof down to form verandah, and line underside with boarding same as eaves. Posts to be 6-in. by 6-in. turned clean jarrah, dowelled at foot each with 1-in. galvanized iron gas pipe into stone curb, 6-in. by 3-in. brackets next walls, built in with ½-in. bolts. Mold mitred around post; 1½-in. thick curtain boards, cut to shape, and fixed to 9-in. by 3-in. redwood top plate. All to detail.

DOORS.—*Front Door.*—Front door to have a 7-in. by 3-in. solid rebated and rounded on outside frame, and 4-in. thick molded transom and side sill.

The frame to be dowelled to stone same as verandah posts, and to have cleats nailed to sides for building into cavity.

Door to be a 3-ft. by 6-ft. 10-in. by $2\frac{1}{4}$-in. thick skeleton-framed door, upper panel in molded sash bars, with slips for glass, lower portion sheathed fair both sides with 4-in. by $\frac{1}{2}$-in. T. and G. and V-jointed boarding. Small stop mold on both sides of lock rail. Side light to match, and with $2\frac{1}{4}$-in. molded fixed sash; $2\frac{1}{4}$-in. molded fanlight over door in two parts, larger part hung with a pair of 3-in. butts, and fitted. Door hung with three 4-in. butts. Ironmongery, 30s. All to detail.

Lobby Door.—Back lobby door to have ditto frame; door 2 ft. 10 in. by 6 ft. 10 in. by $1\frac{3}{4}$ in., in three panels, upper panel in slips for glass. Small quarter round insertion molds throughout. Hang door as above. Ironmongery, 20s.

Inside Doors.—Inner doors to be hung to $1\frac{1}{8}$-in. thick red deal jamb linings, with $\frac{1}{2}$-in. thick stops planted on. Doors other than pantry doors each to be 2-ft. 8-in. by 6-ft. 8-in. by $1\frac{1}{2}$-in. four-panelled, double-molded Queensland hoop pine doors, hung each with three 4-in. butts, and fitted with mortice locks. Ironmongery, 12s per door.

Pantry door to be a 2-ft. 3-in. by 6-ft. 6-in. by $1\frac{1}{4}$-in. two-panelled ditto, hung with two 3-in. butts. Ironmongery, 5s. 6d.

Trap Door.—Arrange for and fit in ceiling of kitchen a small trap door to approval, to give access to roof.

WINDOWS.—*Solid Frame Window.*—The S.W. window of living room to be of redwood, having a 5-in. by 4-in. solid rebated and stop-molded and circular-headed outside frame, supported $2\frac{1}{4}$ in. upon the brickwork, and receiving at sides a $\frac{7}{8}$-in. thick inside lining.

Sill to be 5 in. thick, weathered and molded, and with a pair of small molded brackets under.

Sashes to be $2\frac{1}{4}$ in. thick, in slips for leaded glass, hung each with a pair of 3-in. brass butts. Ironmongery, 12s.

Box-framed Windows.—All other windows to be of red deal,

except sills, which are to be of redwood. All to have box frames and 1-in. in and outside cases, 1¼-in. pulley styles, slips, tongues, &c., and 2¼-in. molded sashes, double hung with best Italian hemp lines through brass-bushed axle pulleys to iron weights, and fitted with ironmongery at 3s. 6d. per window.

Window Boards.—All windows to have 2-in. molded window boards tongued into sills and projecting beyond architraves, with small mold under.

Architraves.—All internal doors and windows to have 6-in. by 1¾-in. molded to detail Queensland hoop pine architraves, mitred at angles, and with molded skirting blocks.

Skirtings.—Skirting to be fixed to narrow red deal grounds plugged to walls. Fit around walls of kitchen a 4-in. by 1-in. rounded on top board as skirting. Fit around all other apartments other than bathroom 11-in. by ½-in. molded and double-faced Queensland hoop pine skirting.

Linings.—Line ceilings of verandah, pantry, lobby, bath, and back portion of passage with 4-in. by ½-in. T. and G. and V-jointed jarrah lining, finished around with small quarter-round mold.

Chimney-Pieces.—Allow the total sum of £15 (fifteen pounds sterling) for three selected chimney-pieces, and fix same.

Fit kitchen fire-place with a 9-in. by 1½-in. mantelshelf, supported on a pair of 2-in. by ¼-in. wrought-iron screwed-up knees.

Kitchen Cupboard. Allow the sum of £3 for cupboard fittings in kitchen.

Sink Top.—Carry sink top on 2½-in. by 2½-in. jarrah legs and 4-in. by 1¼-in. rails and form top of clean kauri in one width, with hole cut out for sink, rounded nosings, and channelled way to fall to sink.

PLASTERER.

Laths.—Lath the ceiling of "beds" 1, 2, and 3, living room, kitchen, and passage with colonial narrow-cut laths, fixed with 18-in. breaks and well nailed.

Allow for plastering all internal walls, excepting only those specified to be cemented.

Stuff.—All lime stuff to lie at least 14 days before being used. Sand to be clean and sharp. Lime freshly burnt and of approved kind, run and sifted.

All plastering to be done in three-coat work.

The first coat (rendering) to be composed of three parts of sand, one part of lime, and a fair quantity of long, well-beaten cow-hair.

The second coat (floating) to have four parts of sand, one part of lime, and a small quantity of cowhair.

The third coat (setting) to be compounded of four parts of lime putty to one part of plaster of paris.

Method.—The first coat on laths to be well squeezed to form good key, walls to be well wetted before plaster is put on. The first coat to be well scratched before the second coat is put on, and the final coat laid thin, smooth, even, and perfectly white and clean.

Angles.—External angles to be backed in 2 in. on each side with Portland cement and sand 3 to 1, and finished smoothly in pure Keen's cement.

External Cementing.—Cement walls of kitchen, pantry, and bath in two-coat work. First coat to have four parts of washed sand to one part of Portland cement. First coat gauged with 2½ parts of fine sand to one part of cement, steel trowelled to hard face.

Rough Cast.—Rough casting to gable to have a first coat of haired stuff mixed with small quantity of cement. Second coat of two parts of clean ironstone gravel to one of cement, thrown on.

PLUMBER.

Sheet Metal.—All sheet iron to be galvanized, skilfully worked up, double rivetted and double soldered at all joints, and with 4-in. end laps ; left free as far as possible for expansion.

Valleys.—Lay valleys with 24-gauge galvanized sheet iron, bent to shape, 16 in. wide.

Spouting. — Eaves spouting to be special-made half-round spouting out of 5-in. by 4-in. 22-gauge. Secured in position every 30 in. with special-made galvanized wrought-iron clips out of $1\frac{1}{4}$-in. by $\frac{1}{8}$-in. iron, screwed to fascias and clipping over front of spouting. Screw back of spouting every 18 in. with galvanized screws and lead washers.

Down Pipes.—Allow for four stacks of down pipes and short lengths from upper to lower eaves. All 3-in. diameter, out of 22-gauge, and with swan-neck bends at eaves, and rounded shoe pieces, secured to walls with galvanized wrought-iron wall hooks, soldered to spouting, and fitted at top with conical galvanized wire strainers.

Flashings.—All flashings to be of 4 lbs. milled sheet lead, properly cut, stepped, and aproned, and secured into joints of work with lead wedges, afterwards pointed up in cement.

In this way, wide flash around at junction of roof covering with chimneys, roof with walls, louvred sill with roof, and wherever else required.

Water.—Lay on from the existing service (which is situated 40 ft. from the bathroom) with $\frac{3}{4}$-in. galvanized welded tubing to two points in "bath," also to lavatory and sink. Allow for all necessary bends, elbows, tees, and fix same in most secure manner, and connect to taps.

Sanitary Fittings.—Allow for selected bath, shower, taps, and bath trap, plug chains, &c., at £12 (twelve pounds sterling), and carry a 2-in. galvanized welded tube waste to discharge into drain just outside wall.

Allow for selected lavatory basin lead P trap with brass inspection screws, brass coupling, nickel plug chain, nickel pillar tap, &c., at £5 (five pounds sterling), and carry a $1\frac{1}{4}$-in. lead waste to discharge outside of wall.

Allow for selected porcelain sink with brass plug and chain, 2-in.

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lead trap with brass couplings and inspection screw, and nickel pillar tap at £6 (six pounds sterling), and carry lead waste to discharge outside wall into surface drain.

Allow for all necessary plumbers' work in wiped joints, screw couplings, wall hooks, &c., to the above.

Gas Service.—Allow for 50 ft. lineal of $\frac{3}{4}$-in. galvanized welded tubing, and connect to the existing acetylene gas plant. Bring this pipe underground, and allow throughout the building a $\frac{1}{2}$-in. black iron pipe service to nine points in house, all well out of sight and properly secured. Allow the sum of £15 (fifteen pounds sterling) for selected gas burners and gas fittings, and fix same. Test and leave gas-proof at completion.

TILER.

Floor Tiles, &c.—Lay floors of verandah, pantry, "bath," lobby, and kitchen hearth with selected tiles at 8s. per yard super. Lay three other hearths ditto at 15s. each hearth, and majolica curbs at 20s. each hearth.

All surfaces to be well wetted before tiles are laid. Tiles themselves soaked in water and set with full body of cement mortar; close fitted, cut to match and pattern; cleaned off with sawdust. Curbs to be fortified with large galvanized nails filled and set in cement.

Roof Tiling.—Cover the whole of the roof with Marseilles pattern tiles of an approved Australian-made brand, all close set to true horizontal lines, cleanly cut and fitted where required, and laid each upon 2-in. by 1-in. and 1-in. by 1-in. mild Oregon battening, nailed to rafters receiving stout copper wiring from each tile.

Cover hips with plain terra-cotta hipping, and the ridges with plain up and down ditto ridging.

Allow the total sum of 50s. (fifty shillings) for three selected finials, and set same. Bed all in haired cement mortar and point up in colored cement stopping.

PAINTER.

Prime the whole of the wrought woodwork throughout the building in a good coat of pure red lead and raw oil. Stop all defects, nail-holes, &c., with putty, and afterwards paint in four good coats of pure white lead and genuine oil, and pigment colors to finish in selected tints. Rub down after each coat, and leave the final clean, level, and perfect.

Paint all spouting, down pipes, &c., in two good coats.

Paint rough cast a warm buff with two coats of approved cold water paint.

GLAZIER.

Colored Glass. — Glaze front door sidelights and fanlights in colored leaded glass to design, at 6s. per super ft.

Clear Leaded Glass.—Glaze S.W. window of living room in 21-oz. sheet glass in lead.

Sheet.—Glaze all other windows with best English 16-oz. sheet glass, well sprigged in and puttied.

FINAL NOTE.

Waiting upon and Cleaning.—Allow for one trade waiting upon and making good after the other, also for cleaning down tiles, walling, and masonry, if discolored, with dilute muriatic acid and clean water.

Remove all paint from floors or glass.

Twice scrub and wash-up all floors, and leave premises perfect and ready for occupation on completion.

Conditions of Contract.—General conditions of contract, containing items affecting the carrying out of the work and dealing with matters which may arise during the term of the contract, such as are not specially allowed for in the speç or in the drawings, are generally attached to the speç. Such conditions are issued by the

various Institutes of Architects, and contain such items as the following :—

1. Interpretation of speç and drawings.
2. Price and amount of payments.
3. Setting out of works.
4. Compliance with local Acts.
5. Insurance upon the building.
6. Time in which to build.
7. Clerk of Works.
8. Plant and property.
9. Access to works.
10. Removal of defective work.
11. Subletting of the work.
12. Penalties for overtime.
13. Arbitration in case of disputes.
14. Alterations, extras, and final measurements.
15. Return of drawings.
16. Space for signatures of contractor, proprietor, and witnesses.

Quantity Taking.—After completion by the architect of working drawings and specifications for a proposed building, it is usual to call for tenders.

This may be done by asking a limited number of reputable builders upon a given day and time to send in a price, or the more common method of advertising in the daily press may be adopted, the former being called "private tendering" and the latter "public tendering." In a few cases work is carried out by day labour—*i.e.*, by employing workmen by the day or piece to carry on the work under personal supervision.

In tendering the contractor's chief business is to form an exact estimate of the class and amount of work to be done. In works of any considerable size, "bills of quantities" are prepared and issued to the builders. These are priced item by item, and the total is handed in to the architect as the amount of the tender.

In smaller jobs each builder is usually given a night in which to take off his own quantities, or he may be allowed facilities in the architect's office to see the drawings and specifications during the day, for the purpose of preparing an estimate.

A bill of quantities is a document prepared by a quantity surveyor, and is arranged so as to show at a glance the actual amount of each separate kind of material required or character of work to be done in the various trades.

The preparation of quantities is the legitimate method employed in the best practice, not only for the purpose of obtaining tenders, but also for checking and adjusting variations, such as alterations, deductions, or additions to the work actually carried out, as the bill of quantities, having the prices extended item by item into the money column, forms a valuable basis of adjustment at the end of the job.

Quantity surveyors' methods differ somewhat in the various States, but effort is usually made to so produce the bill as to show each item in the manner it is generally dealt with by the builder, so as to facilitate both clear understanding and ready pricing.

There are three processes in quantity taking—firstly, the "taking off;" secondly, the "abstracting;" and thirdly, the "billing." "Taking off" consists in actually measuring, by means of the scale and by the aid of the interpretation of the specification, the quantity, part by part and piece by piece, of each class of work in the job, entering them upon specially ruled paper, usually spaced in four columns, the first containing the "times-ing" or number of times the dimension will repeat, the second the dimensions, the third the result of the squaring, and the fourth (the widest) for the description of the item.

Abstracting is the second operation, and consists of arranging the items in the various trades under their various headings, and in certain relative positions.

Billing is the final process, whereby the finished bill is drawn up, and where the collected items from the abstracts are arranged in

their proper order, and with their full descriptions added, to enable the builder to place his prices against them, and to price them out in the money columns.

ROUGH QUANTITY TAKING.—If quantities are not supplied each builder adopts his own method of estimating, and as the time at the disposal of each tenderer is always very limited, this method of quantity taking must needs be more or less speculative, and depends for its success, in a very large measure, upon the experience of the builder with the carrying out of work of a similar class.

No standard can here be laid down for such rough quantity taking, but by referring to the drawings of the large suburban villa upon Plate IV., Chapter IV., as a type, a usual method of itemizing such a job may be here given. From the outset the specification must be closely followed, and the items taken as they occur in the speç, so that nothing is missed.

Commencing with "Generally," all items therein contained that need allowing for, such as fees, insurance, provisional sum, clearing site, &c., are noted.

In Excavator the digging and removing is taken at per yard cube, as also the laying in of concrete to trenches and under floors or hearth tiles.

Paths at per super. yard.

In Mason.—Stone steps, thresholds, copings and verandah curbing are described and taken at per foot lineal.

In Bricklayer.—The whole of the brickwork is taken at per rod, usually over all openings, which allows for arches, bars, fair building, &c., with an extra superficial measurement if special jointing or tuckpointing is used to certain visible surfaces.

Hollow and solid walls are taken separately.

Fire-places and chimneys are taken with general brickwork. Chimney-pots are taken at so much each, with the cost of fixing added.

Overhead concrete lintels to bays, &c., at per cube yard.

Vents through walls at so much each, including everything.

Grates.—Mention lump sum given in speç, mention number, and allow extra for fitting.

Ditto, kitchen range.

Copper.—Item. Add for fire-box, door, damper, and copper boiler.

Surface drains at per foot lineal.

In Carpenter.—Floors may be taken complete, including plates, bearers, joists, and flooring, at per square (10 ft. by 10 ft. super). Special polished flooring kept separate.

Roofs may be taken at per square, exclusive of covering, and ceilings at per square, or hips, valleys, ridges, hanging beams, and similar larger timbers may be taken off separately and the residue squared.

Eaves can be taken at per foot run, and described, exclusive of spouting.

Gables.—Take out amount of timber, add labor.

Pents.—Ditto.

Verandah posts at so much each. Balustrades at per foot lineal, also frieze. Ceiling at per square.

Tower.—Take off timber, add labor, especially for circular work.

Windows.—Ordinary at so much each fixed, including architraves, window boards, fastenings, glass, &c. Special windows at per super. foot.

Bays.—At per foot super. over all as received from joiner's shop.

Add for fittings and fixing and glass.

Doors.—Ordinary, according to class, including linings, stops, and architraves, locks, furniture, &c., at so much each.

Special doors, such as front door, same as bays.

Glass screen in pantry at per foot super.

Finishings, such as skirtings, picture molds, &c., describe and take at per foot lineal.

Shelving at per foot super., including brackets.

Wash troughs at per set. Add for stands.

Bay seat at per foot super. Add for stand.

Sink top.—Ditto.

Kitchen dresser.—Item.

Scullery sink.—Item.

Boards to front of fuel at per super. foot. Add labor.

Bedroom cupboard may be taken as item.

Three wood grilles at so much each fixed.

Chimney-pieces.—Take price allowed in speç. Add fixing.

Woodwork to low tower, complete, ready for plumber. Take off each item and add for circular and curved work.

Fencing.—Side paling from description at per foot lineal, as also back, with item for gates and gate posts.

Front picket fencing also at per foot lineal, and add for gates and posts.

In Plasterer.—Cement wall surfaces, ordinary plaster or brick-work.

Plaster on laths, such as to ceilings, each separate, at per yard super., and describe the finish.

Run cornices at per foot lineal, mentioning girth.

Internal plaster face vents at so much each, fixed.

Outside plain cementing at per super. yard.

Rough cast ditto.

Run molds at per foot lineal, mentioning girth, and counting mitres.

Pressed enrichments—describe, give over all size, and item to be purchased from shop modeller. Add for fixing.

Coloring cement at per super. yard.

Fibre ceilings to hall, diningroom, drawingroom, and best bed-room, with cornices, item mentioned in speç for work fixed by the firm supplying same.

In Plumber.—Roof plumbing, such as sheet-iron valleys, eaves, spouting, and down pipes, at per foot lineal.

Tower roof—copper by weight; add labor, finial, and fixing.

Water Supply.—Take main connection and labor of tapping the main and of fixing meter. Pipe at per foot run; add extra per point.

Flashings to roof, &c., and lead floor to bathroom at per cwt.; add labor.

Sewerage connections—pipes of various classes at per foot lineal, with price given in speç for all fittings, such as bath, lavatory, W.C. pans, traps, seats, cisterns, &c. Traps, cowls, storage tank, taps, &c., at so much each. Add fixing to ordinary price to be paid for each article.

In Tiler.—Tiles on roof, including battens and copper nailed, at per square. Ridging at per foot lineal, according to class. Finials at so much each, mentioned in speç, and add for fixing.

Tiles for walls and floors at per super. yard at price given for tiles; add for cement and sand and labor in fixing. Mention whether on walls or floors.

Tiled hearths, if mentioned in speç at so much each for tiles, may be taken ditto, or as items. Majolica curbs at so much each, and add for sand and cement and nails and fixing.

In Glazier.—Glass, if not taken with doors or windows, may be taken separately. Special glass, such as Muranese or leaded glass, at per foot super. Add fixing.

In Electrician.—It is usual to obtain price from electrician for bell work, or allow so much per point and add price allowed in speç for presses, &c.

In Gasfitter—Take pipe at per ft. lineal, and add cost of fittings. Add also for fitting at per point.

In Painter.—Painting according to class, whether varnished, flatted, or ordinary, at per super. yard. Windows may be numbered or apartments may be taken and averaged.

Washing Out.–Scrubbing floors, cleaning windows, clearing away rubbish, and preparing for occupation, items.

PROFIT.—A percentage upon the whole.

Cubeing.—A method of rough estimating often adopted by architects is to cube up a proposed building from the drawings. This consists of measuring the cubical contents of the building and pricing it at so much per cube foot, according to the character of the work.

The dimensions are usually taken from the bottom of the foundations to half-way up roof, multiplied by the length and breadth of the masses. The product may then be multiplied by a price—say in the case of an ordinary villa at perhaps 6d. per cube foot, or 4d. if the building be of wooden structure, or from 8d. to 1s. if partly of stone and of special finish.

It must be distinctly understood that such a method of estimating can only be approximate, and the price per cube foot at which the work is calculated can only be determined from experience of similar work erected under similar conditions.

Some such rough method is also at times made by taking the super. area of a building and pricing it at so much per square.

Pricing.—No attempt can here be made to offer suggestions for pricing builders' work. This branch of practice can only be undertaken by men engaged closely in dealing with actual building, who, in addition, study narrowly both the material and labor markets—factors that are constantly changing, and factors, too, that require to be applied to each new work with fresh regard to each peculiar case.

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